

# Lower Thames Crossing

## Appendix 8.15 – Construction and Operational Light Spill Calculations

APFP Regulation 5(2)(a) & 5(2)(g)

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# Appendix 8.15 – Construction and Operational Light Spill Calculations

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# 1 Introduction

- 1.1.1 This appendix sets out the indicative light spill resulting from the construction compounds and operational road lighting for the Lower Thames Crossing (here after referred to as the Project).
- 1.1.2 The indicative light spill calculations have focussed on the potential sensitive ecological receptors and support the Terrestrial Biodiversity Assessment chapter and the Habitats Regulations Assessment.

## 1.2 Scope of the assessment

- 1.2.1 The scope of the assessment is limited to identifying the potential extent where light spill levels could potentially exceed 0.5 lux as a result of the construction and operational lighting as shown in Table 1.1.

**Table 1.1 Scope of lighting assessment**

Light Spill from	Potential receptor
<b>Construction lighting</b>	
A2 compound	Shorne and Ashenbank Woods SSSI
Southern tunnel entrance compound	Bat roost areas north of compound
A226 Gravesend compound	Thames Estuary and Marshes Ramsar/SPA functionally linked land
Milton compound	
Northern tunnel entrance compound	
<b>Operational lighting</b>	
Highway lighting on junction between the Project and the A2	Shorne and Ashenbank Woods SSSI
North Portal and Station Road	Thames Estuary and Marshes Ramsar/SPA functionally linked land Invertebrate mitigation area
Highway lighting on junction between the Project and the M25	Manor Farm bat roosts
Highway lighting M25 Jct 29	Invertebrate area

## 2 The Proposed Approach and Assumptions

### 2.1 Compliance with Best Practice and Standards

2.1.1 The concept of 'Environmental Zones' was introduced by the Commission Internationale de l'Eclairage in CIE 150: 2017 and updated by the Institution of Lighting Professionals (ILP)(2020) and this has been used to inform this Light Spill Study. The Environmental Zone classes are set out in Table 4.1, which references Environmental Zones from the ILP. GN01: 2020 Guidance Notes for the Reduction of Obtrusive Light. The existing lighting context of the area surrounding has been considered against this system of lighting classification to develop appropriate levels of lighting performance set within this LMP.

2.1.2 The following external lighting standards and guidance documents have informed the lighting strategy and minimum requirements for the construction and operation lighting, for the temporary construction compounds.

#### British Standards

2.1.3 BS 5489 – 2020 Code of practice for the design of road lighting – Part 1: Lighting of Roads and Public amenity areas.

2.1.4 BS EN 13201 – 2003 Road lighting- Part 2 - performance requirements

2.1.5 BS EN 12464 – 2014 Light and lighting of workplaces- Part 2- outdoor workplaces

#### Local Policy

2.1.6 Dark Skies Policy

#### Other Regulations

2.1.7 Institution of Lighting Professionals (ILP)/ Chartered Institute of Building Services Engineers (CIBSE) / Society of Light and Lighting

2.1.8 ILP. GN01: 2020 Guidance Notes for the Reduction of Obtrusive Light

2.1.9 ILP GN08: Bats and Artificial Lighting in the UK (2019)

2.1.10 ILP – High masts for lighting and CCTV - Professional Lighting Guide (PLG) 07 (2013 edition)

2.1.11 CIBSE Building Regulations Approved Document L2B (with particular reference to metering and CIBSE TM39)

2.1.12 SLL, Lighting Guide 1 – The industrial Environment 2018

2.1.13 SLL, Lighting Guide 6 – The Outdoor Environment 2016

### 2.2 Approach used and Assumptions

2.2.1 Where and when construction activities are taking place, areas would need to be lit 24/7. This is particularly relevant for the Northern tunnel entrance and southern tunnel entrance compounds, which would have material extraction/storage activities taking place 24 hours a day in the 'main construction area' part of the overall compound in the vicinity of the portals. Other areas around the periphery of the proposed compounds, used for topsoil storage, bulk storage of materials etc. would typically be limited to security lighting rather than higher level construction lighting.

- 2.2.2 The temporary construction accesses would only be lit by exception where there is a specific security/safety issue e.g. at access points, next to a bridge or other particular traffic hazard, area with restricted visibility for approaching drivers (public and construction), or pedestrian routes etc. These areas would be subject to a risk assessment. Mitigation would also be used in such areas such as reflectors/shields to control light distribution and glare to drivers, and where possible avoiding the need for lighting (reducing vehicle speed limits, limiting night time use of sensitive areas where possible etc.).
- 2.2.3 In summary, lighting would be required for safety reasons, when working in hours of darkness, including but not limited to 24-hours a day on the areas of the site near to the portals.

## 2.3 24/7 Working

**Table 2.1: Work duration and hours for compounds assessed**

	<b>Approximate total duration of compound/activity</b>	<b>Associated Operations (where lighting may only be required at certain times)</b>
Southern tunnel entrance compound	Estimated 5 years (~5 years activity) Estimated earliest commencement 2025	Total indicative period of inactivity 0% Day working, overnight security and 24 hour working (all works)
A2 compound	Estimated 6 years (~5.5 years activity) Estimated earliest commencement 2025	Total indicative period of inactivity 40% Day working, overnight security and 24 hour working (for utilities works and some highways works)
A226 Gravesend Road compound	Estimated 2 years (~1.5 years activity) Estimated earliest commencement 2025	Total indicative period of inactivity 40% Day working, overnight security and 24 hour working (tunnelling work only)
Milton compound	Estimated 2 years (~1.5 years activity) Estimated earliest commencement 2025	Total indicative period of inactivity 40% Day working, overnight security and 24 hour working (tunnelling work only)
Northern tunnel entrance compound	Estimated 5 years (~5 years activity) Estimated earliest commencement 2025	Total indicative period of inactivity 0% Day working, overnight security and 24 hour working (all works)

## 2.4 Good Practice Measures

- 2.4.1 The Project has committed to a number of measures to avoid and reduce the effects of lighting on the surrounding area as follows.

### Construction Lighting

- 2.4.2 The Project CoCP sets out the following measures to avoid and reduce light pollution during the construction phase.

- 2.4.3 Site lighting and signage will be provided by the Contractors to ensure the safety and security of the construction sites. It will be at the appropriate luminance required to provide safe working conditions. Where needed and appropriate, lighting to site boundaries will be provided, and illumination will be sufficient to provide a safe route for the passing public. Precautions will be taken to avoid shadows cast by the site hoarding on surrounding footpaths, roads and amenity areas. Where appropriate, lighting will be activated by motion sensors to prevent unnecessary usage.
- 2.4.4 Site Lighting will comply with the Institution of Lighting Professionals Guidance Notes for the Reduction of Obtrusive Light GN01/20 (2020) and the provisions of BS EN 12464 2014 Light and lighting of workplaces- Part 2- outdoor workplaces, where applicable.
- 2.4.5 Lighting will also be designed, positioned, and directed to prevent or minimise light disturbance to nearby residents, ecological receptors, as well as motorists, and rail and marine operations. This provision will apply particularly to sites where night working, or security lighting will be required.
- 2.4.6 Dimmable or switchable lighting levels shall be used in all locations where construction task lighting (higher lighting levels for tool use, plant operation etc.) is not required for the full night time hours i.e. lighting levels would be reduced during periods when sites are inactive with lighting only needed for security purposes.
- 2.4.7 Low energy light sources shall be used for all construction lighting unless otherwise specifically accepted by National Highways. Any site-specific lighting controls will be described in Contractors' EMP2s.

### Operational Lighting

- 2.4.8 The operational lighting design is described in ES Chapter 2 Project Description (Application Reference 6.1) include the following measures, relevant to this assessment, that would reduce the effect of light spill on the surrounding habitat.
- 2.4.9 Road lighting will comply with the Institution of Lighting Professionals Guidance Notes for the Reduction of Obtrusive Light GN01/20 (2020) and the provisions of BS 5489-1, Code of Practice for the Design of Road Lighting (BSI, 2020).
- Column heights have been kept as low as practicable while still providing a compliant lighting design
  - Luminaires have been selected which emit no light above the horizontal to reduce skyglow and ensure light is only projected to where it is needed
  - The lighting columns would be placed in the verges projecting towards the central reserve wherever practicable to reduce light spill into adjacent areas
  - Luminaires have been used which require no tilt angle (i.e. they are mounted fully horizontal) to reduce the potential for direct views of the light source from beyond the highway boundaries

## 3 Construction High Level Assessment

### 3.1 Environmental Zone

- 3.1.1 There are various environmental considerations that need to be taken into account when considering the installation of exterior lighting. These are the direct energy usage, the visual impact of the lighting equipment during the day, the effect of light spillage on surrounding areas, the spill of light into the night sky, and the effects on human receptors, animal, plant life and surrounding landscape.
- 3.1.2 The Institution of Lighting Professionals (ILP) document “GN01: Guidance notes for the reduction of obtrusive light (2020)” and International Commission on Illumination CIE 150: 2017, establish five Environmental Zones. Each zone has a different approach to the provision of external lighting. These zones establish ‘Obtrusive Lighting Limitations for External Lighting Installations’ and include the effects of ‘Sky Glow’ and maximum values of vertical illuminance on properties. The document also includes ‘limits for the luminous intensity of bright luminaires’; the potentially obtrusive direction of light outside the area being lit. The zones are listed in table 2 of the ILP. GN01: 2020 Guidance Notes for the Reduction of Obtrusive Light, which is included as Table 4.1 below.
- 3.1.3 The proposed construction compounds are generally situated in a rural transitioning into suburban locations.
- 3.1.4 The area around the proposed compounds has been assessed as E2 as outlined in table 2 of the ILP. GN01: 2020 Guidance Notes for the Reduction of Obtrusive Light (in Table 4.1)

**Table 3.1: Environmental Zones**

Table 2: Environmental zones			
Zone	Surrounding	Lighting environment	Examples
E0	Protected	Dark (SQM 20.5+)	Astronomical Observable dark skies, UNESCO starlight reserves, IDA dark sky places
E1	Natural	Dark (SQM 20 to 20.5)	Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty, IDA buffer zones etc.
E2	Rural	Low district brightness (SQM ~15 to 20)	Sparsely inhabited rural areas, village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Well inhabited rural and urban settlements, small town centres of suburban locations
E4	Urban	High district brightness	Town/city centres with high levels of night-time activity

## 3.2 Indicative Compound Layouts

- 3.2.1 The lighting for each construction compound will be designed by the contractor when the compounds layout details are finalised. The compound and associated light levels presented on the drawings in Annex A are the indicative layouts that have been used by other topic areas, e.g. noise and vibration for the environmental impact assessment.
- 3.2.2 All areas, for the purposes of understanding potential spill light, have been lit to an average of 50 lux with a maximum column height of 12m. Section 3.4, Table 3.2 outlines the typical lighting levels expected for each area within a compound. This represents a reasonable ‘worst case’ scenario and once the compound design is finalised the lighting levels may be higher or lower than assumed in this assessment. A Maintenance factor of 1 has been used so results are consistent with what would be expected on the first day of compound operation.
- 3.2.3 The primary objective of lighting during the construction phase is to provide illumination for construction activities, providing a safe working environment in the absence of natural light, allowing workers and site traffic to safely undertake various construction-related tasks and to provide security lighting.
- 3.2.4 The proposed compounds are considered to be within an E2 Environmental Zone. The required lighting therefore needs to be designed to minimise impact on the surrounding environment.
- 3.2.5 The objectives of the construction lighting are to achieve the following:
- a. provide a safe working environment, meeting statutory requirements and standards
  - b. allow 24hr working (when required)
  - c. provide site security lighting
  - d. mitigate the impact of artificial lighting on the surrounding environment as far as reasonably practicable.

## 3.3 Required Lighting Levels

- 3.3.1 Due to the dynamic nature of a construction site, different levels of illumination are needed for certain tasks or stages in the construction process, in order to provide a safe working environment. Some areas would require a higher light level suitable as task lighting for detailed work, while other areas would require lower light levels for pedestrian movement or CCTV operation only.
- 3.3.2 Task lighting – Task lighting would typically be provided for construction activities and the required levels would vary depending upon the type of activity being undertaken. For example, clearance, excavation and loading typically requires an average of 20 lux, whereas undertaking fine work such as framework element mounting, light reinforcement work, piping and cabling typically require an average of 100 lux or more. There are various standards with various lighting levels which set out the required lighting levels for the various tasks that would need to be undertaken and indicative levels can be found in Section 4 of this document. The most appropriate standard shall be used.



- 3.3.3 Task lighting would also be required at security check points to allow the inspection of vehicles entering and exiting the site and any associated paperwork etc. It shall be the responsibility of the Contractor to undertake the design of any required task lighting making sure it meets with the required standards, and that is only switched on whilst construction activities are actually being undertaken.
- 3.3.4 Ambient lighting – Ambient lighting would be constant and typically be provided to aid the safe navigation for areas such as access roads, footpaths, car parks and contractors' compounds. Typical levels would be an average of 5 to 50 lux, depending on the area to be lit. There are various standards which set out the required lighting levels for the various tasks that would need to be undertaken and these can be found in Section 3.4 of this document. The most appropriate standard shall be used. Where ambient lighting is identified as 'required', it would be implemented whenever natural light levels are insufficient.

## 3.4 Assumed lighting targets

- 3.4.1 Table 3.2 sets out the assumptions made in the selection of target light levels for the various construction activities, and these have been used to calculate the indicative light spill from the construction compounds.

**Table 3.2: Indicative lighting levels assumed at all compounds for the purposes of this assessment**

Description	Assumed lux level during construction	Maximum Degree of tilt	Upward lighting	Comments
Topsoil Strip Storage Area, Drainage Ditch for Site Run-Off/Protection to River Thames Watercourse, Public Perimeter Footpath Maintained * Limited Volume Expected Due To Current Nature Of Existing Landfill And Current Use Location 15 Slurry Treatment plant. Location 33 Settlement lagoon	Task lighting 50 lux average with 25 lux average.	10° tilt	None assumed	Task lighting would be required exceptionally when there is a requirement to carry out material movements or essential maintenance in hours of darkness. There would typically be no ambient lighting in these areas, as they are expected to be used infrequently during hours of darkness. Any fixed lighting in these areas would only operate when there is a requirement to access the area.
Segment Casting Factory,	General lighting 50 lux. Localised tasks 200 lux to 500 lux average dependent on the safety standard lighting requirements for a specific task.	10° tilt, with main area lighting mounted on columns ranging from 6m to 12m	Yes –when specific types of casting are required Contractor would require upward and downward light to comply with safe working requirements. This would be for limited periods of time	Various levels for task and ambient lighting would be required in this area. The facilities would be housed within a portal-framed enclosed structure to allow working on a 24-hour basis, in line with the TBM advancement
Factory and Storage Yard For Culverts/Roadway Planks 295 X 174M (41,782M <sup>2</sup> ). Portal Compound:- Ventilation Fans/Ducting Storage (Each Fan And Switch Gear 10 X 10M Each Tunnel, 15 X 30M Storage) Rigging Workshop/Stores (4 X 20Ft Containers) Compressor And Receiver Station (10 X 10M); Backup 2Mva Diesel	50 lux average with 25 lux average.	10° tilt Maximum 12m columns assumed where practicable.	None assumed	Task lighting would be required exceptionally when there is a requirement to carry out material movements or essential maintenance in hours of darkness. The helipad would be lit to the required aviation standards but would be used for very limited periods at night in case of emergency. Ambient lighting would



Description	Assumed lux level during construction	Maximum Degree of tilt	Upward lighting	Comments
Genset(2No 20Ft Containerised Plus Tank) First Aid/Medical Room (10 X 10M Plus Parking);Helipad Reserved Area (50 X 50M)				mainly be limited to the roads and car and HGV parking areas.
<p>Laydown Area For TBM Assembly (TBM 2 Assembly Concurrent With TBM 1 Operation)(2 No 50 X 100M) Includes Segment/Grout Car Loading Areas To Ramp</p> <p>Potential Area for Contaminated Ground Treatment/Storage With Water Run-Off (Potential Soil-Washing, Aerobic Bioremediation, Stabilisation/Solidification)225 X 368M (82,000M<sup>2</sup>) Location 8 Water treatment plane. Segregated Waste Area - Recyclables- Steel/Metal,(Main Area Plus Satellites) Plant Yard, wheel wash, Bunded Diesel Tank For Site Vehicles Bunded Diesel Tank For Site Vehicles Cross Passage Yard Scl Batcher/ Mixer Truck/Holding Tanks/Concrete Pumps/Excavator/Formwork/Membrane Storage 200 X 150M (30,000M<sup>2</sup>) Batcher Washout), General Loading Out Area Nbound &amp; Sbound, Ground Engineering /Dewater/Freeze/Grout Yard And Stores (50 X 50M) Workhops Fitters, Electrical, Plc Electricians, (2No Sheds 15 X 25, 1No 10 X 10M) pipe storage, location 27</p>	<p>50 lux average with 25 lux average. Localised tasks 200 lux to 500 lux average dependent on the safety standard lighting requirements for a specific task</p>	<p>10° tilt Maximum 12m columns assumed where practicable.</p>	<p>None assumed</p>	<p>Task lighting would be required when there is a requirement to carry out material movements or essential maintenance in hours of darkness.</p>


Description	Assumed lux level during construction	Maximum Degree of tilt	Upward lighting	Comments
General laydown area MEP laydown area, Joiners yard, site batcher.				
Canteen, Changing Rooms (Clean and Dirty Side), Showers, Toilets For 1428 Persons Per Day Carpark And Bus Stop/Turning Circle, Tunnel Office/Yard Office/Tally Hut & Self Rescuers 40 Persons. Main Admin And Project Management, Design Office Clients Rep, Reception, Visitor's And Induction Centre 109 Persons (2400M <sup>2</sup> ) Meeting Rooms, Medical Lock/Hyperbaric Supervisors' Compound And Saturation Workers Accommodation, stores. Workers Quarters, Car Park and Bus Park	Various levels depending on area. Footpaths and roads around the main site but not including the access road from the main site area. Would be lit to minimum safe levels for security and safety also the use of proximity sensors would be considered where practicable.	10° tilt. Lighting columns would be a maximum of 6m and where possible attached to building structures. Bus and car parks would have maximum column height of 12m.	None assumed	Ambient lighting would be required. Car and Bus parks and footpaths for safe walking to and from office and welfare facilities.
Electrical substation and security. Permanent and temp substations	50 lux average with 25 lux average. Localised tasks 200 lux to 500 lux average dependent on the safety standard lighting requirements for a specific task	10° tilt. lighting mounted on columns ranging from 12m to 6m	None assumed	Task and ambient lighting to specific lighting levels within the substation area. Consider motion sensors when area is unmanned. Security lighting when unmanned.

### 3.5 Lighting Equipment & Controls

- 3.5.1 The Contractor will specify the lighting equipment in accordance with the requirements of the Project. Table 3.3 gives examples of acceptable products and installations that could be used, and examples of equipment and installations that are not acceptable, would not be in accordance with Project requirements and therefore would not be used.
- 3.5.2 This document does not specify specific products as advancements in lighting control is ongoing and we cannot say what products would be available in the future. What we can say is lighting would be controlled and upward light would be controlled where practicable. Consideration would be given to solar powered lighting products in areas away from the main site. Future new technologies would also be evaluated at the time of detail design. Lighting standards are being reviewed and updated regularly and these would also be assessed at the time of detailed design.

**Table 3.3: Luminaires and installations examples**

Acceptable Products/Installations		Unacceptable Products/Installations	
	Example of a good LED flat glass full cut-off luminaire with good optical control and custom shield. For column mounting.		Example of a poorly shielded luminaire that would still produce upward light. Replacement is a better option.
	Example of a good LED flat glass full cut-off area luminaire. For column or building / surface mounting.		Example of poorly installed and aimed area luminaires.
	Example of a good LED flat glass full cut-off luminaire with good optical control. For building / surface mounting.		Example of bad building / surface mounting luminaire with no optical control.

Acceptable Products/Installations		Unacceptable Products/Installations	
	Example of portable site lighting unit with well positioned luminaires.		Example of bad portable balloon-type lighting with no control of upward light.

### 3.6 Mobile lighting unit operation

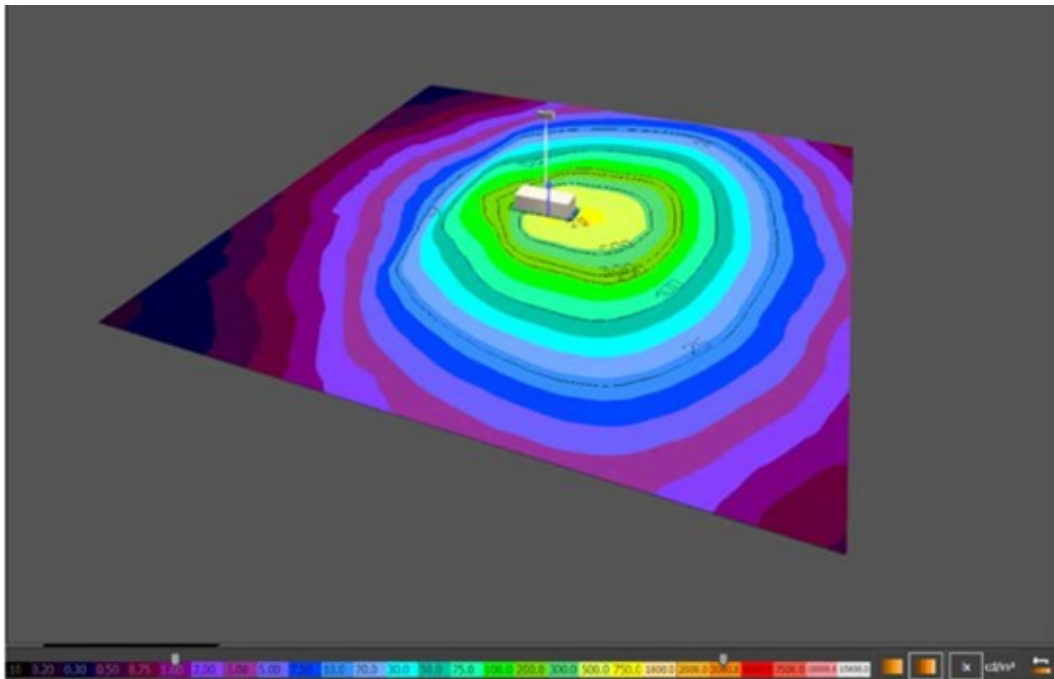
3.6.1 The requirement for supplemental lighting in varied locations around the construction sites requires careful planning and consideration to sensitive light receptors in and around the site. For instance it is an offense to disturb bat roosts, and projecting lighting on/in to and roost access can stop the bats from emerging, thereby disturbing the roost, and perpetrating an offense.

3.6.2 Good practice would be adopted and would involve:

- a. Close monitoring of these mobile lighting units would be required when they are needed to supplement lighting around the boundary.
- b. Knowledge of where the key sensitive receptors are in relation to night-time operations and careful placement of mobile lighting units to ensure that no extraneous light is falling onto these locations.
- c. Mobile units require backlight shields and need to be directed away from the key sensitive sites.
- d. The contractor would be responsible for training the operatives in how to correctly position the mobile units and make them aware of the locations of the key sensitive receptors. The temporary lighting would be monitored by the contractor’s Environmental Clerk of Works.

3.6.3 Plate 3.1 shows an example of a typical mobile lighting tower rig with four luminaires mounted at approximately 9m and the lighting levels achieved.

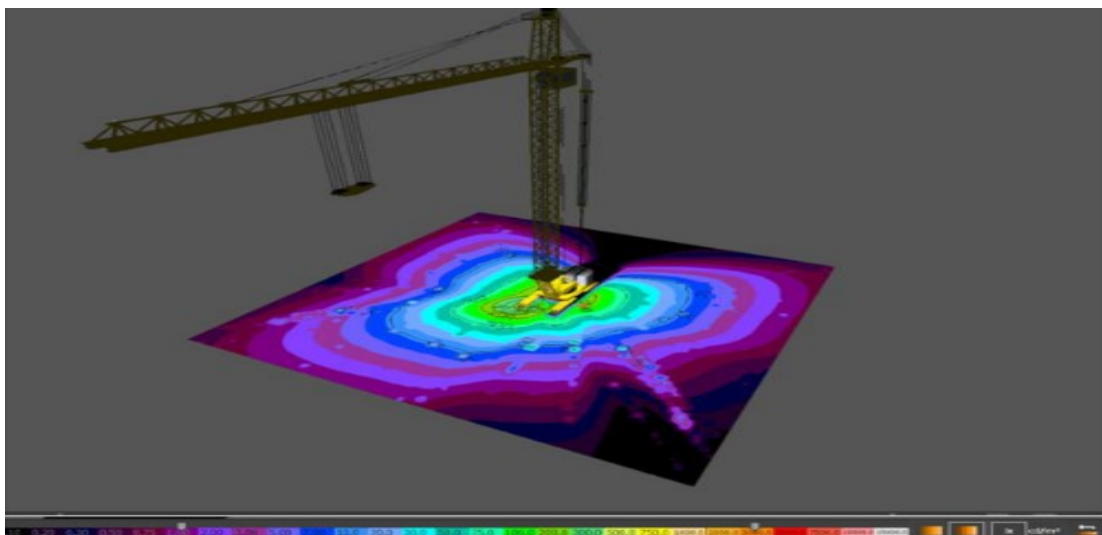
**Plate 3.1 Example of light distribution of mobile lighting unit**



### 3.7 Crane Lighting

3.7.1 Within the compounds CA3, CA3A, CA3B and CA5 it has been assumed that cranes would be required and a maximum height of 45m has been assumed for the purposes of this assessment. This would have specific luminaires to light the crane hook when in operation (Plate 3.2). The lights would have a 0° tilt since their purpose is to enable the crane operator to see the crane hook whilst operating. Aircraft warning lights would also be required on the crane.

**Plate 3.2: Example of crane lighting**

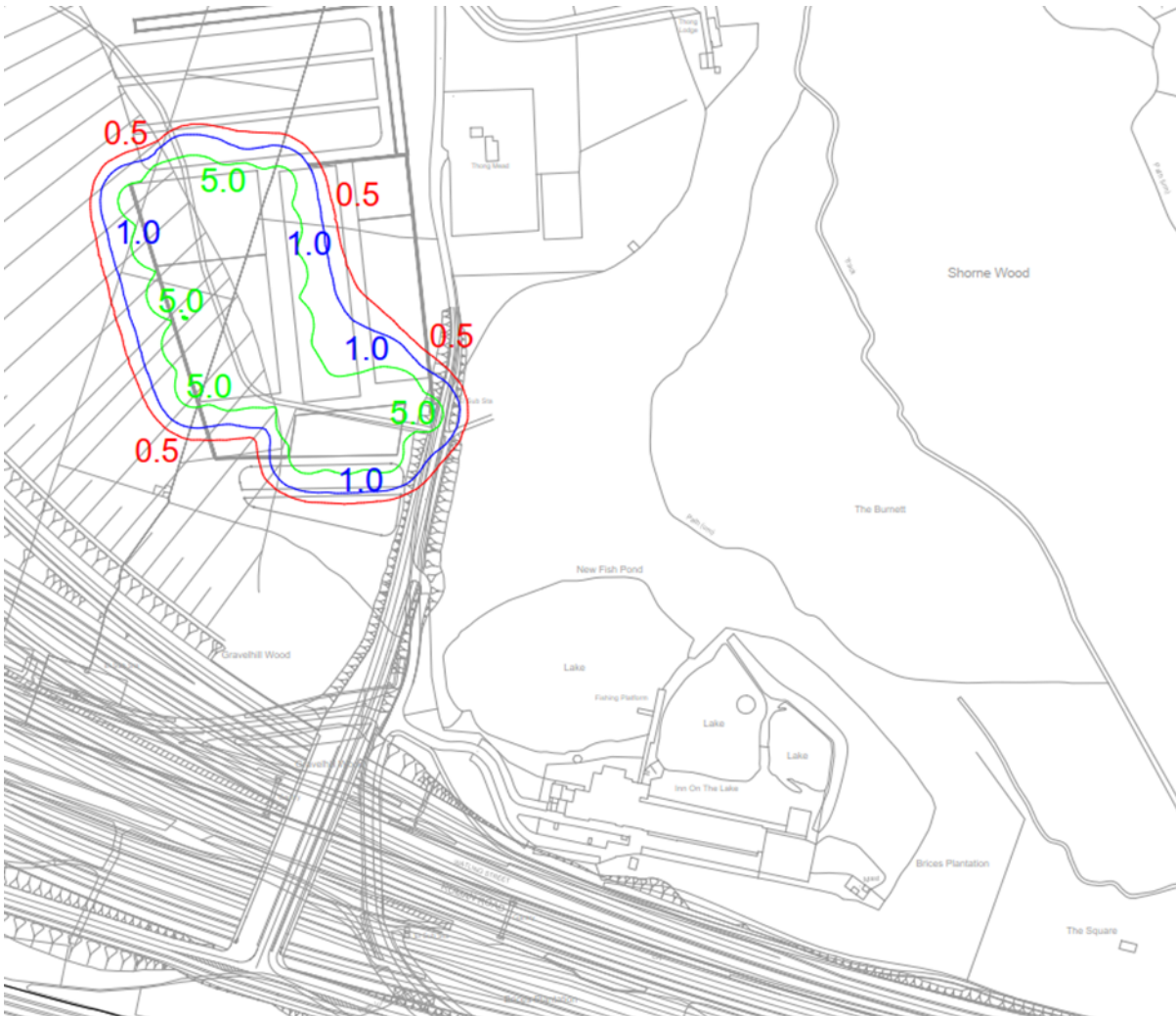


### 3.8 Predicted Light Spill

3.8.1 This section gives an overview of light spill at each compound and for reference purposes the 0.5 lux line has been indicated as a red line.

#### A2 compound

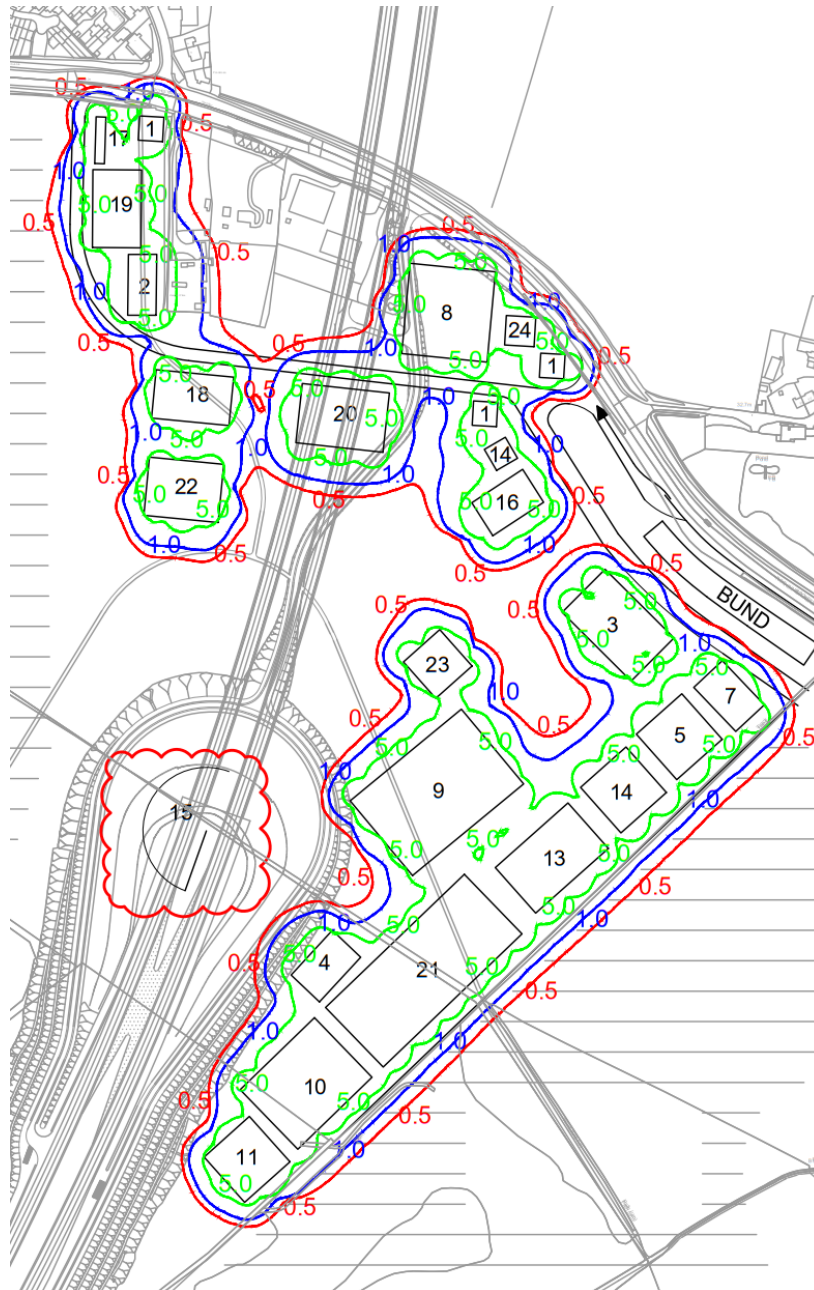
**Plate 3.3: A2 Compound – predicted light spill at Shorne and Ashenbank Woods.**





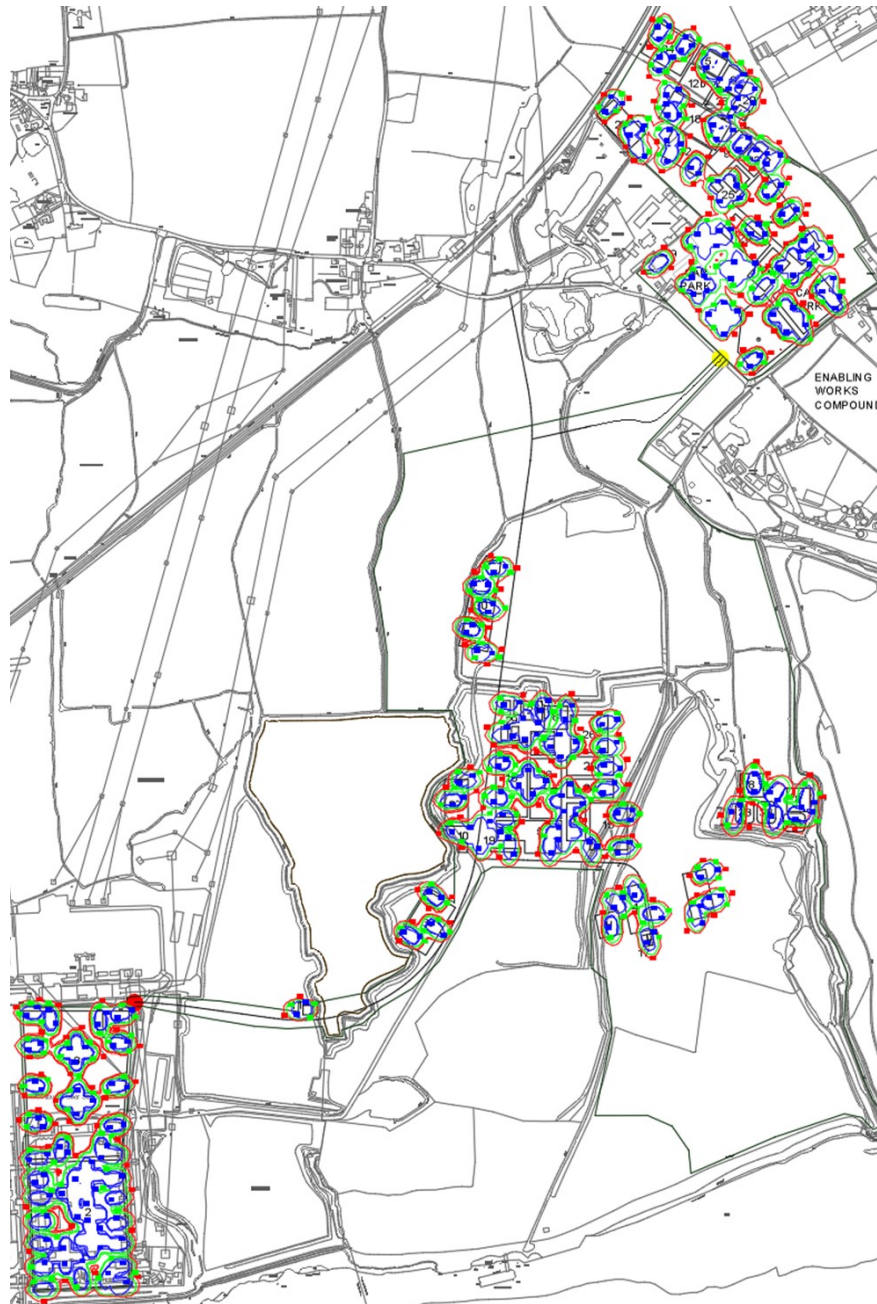
### Southern tunnel entrance compound

**Plate 3.4: Southern tunnel entrance compound – predicted light spill in relation to bat roost areas north of compound**



## Northern tunnel entrance compound

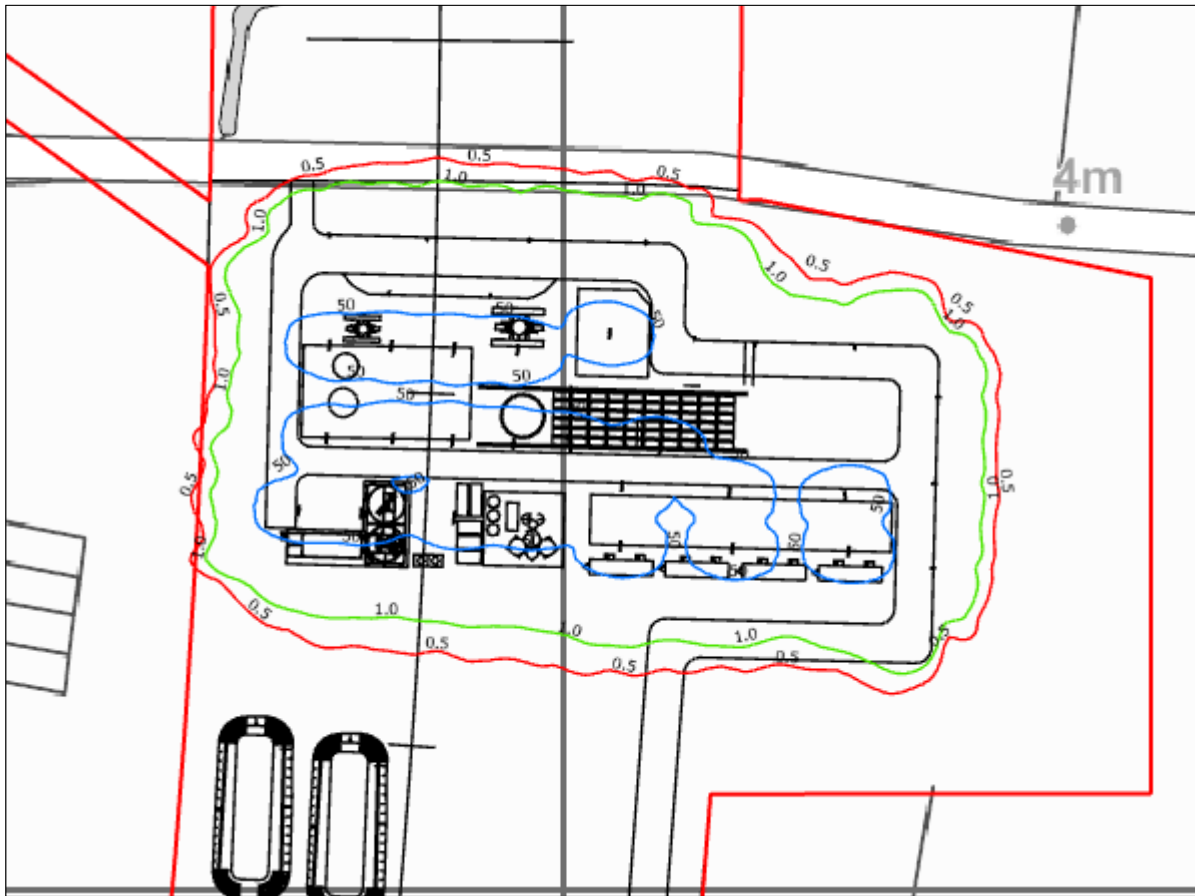
**Plate 3.5: Northern tunnel entrance compound – predicted light spill within the adjacent Thames Estuary and Marshes SPA/Ramsar functionally linked land**





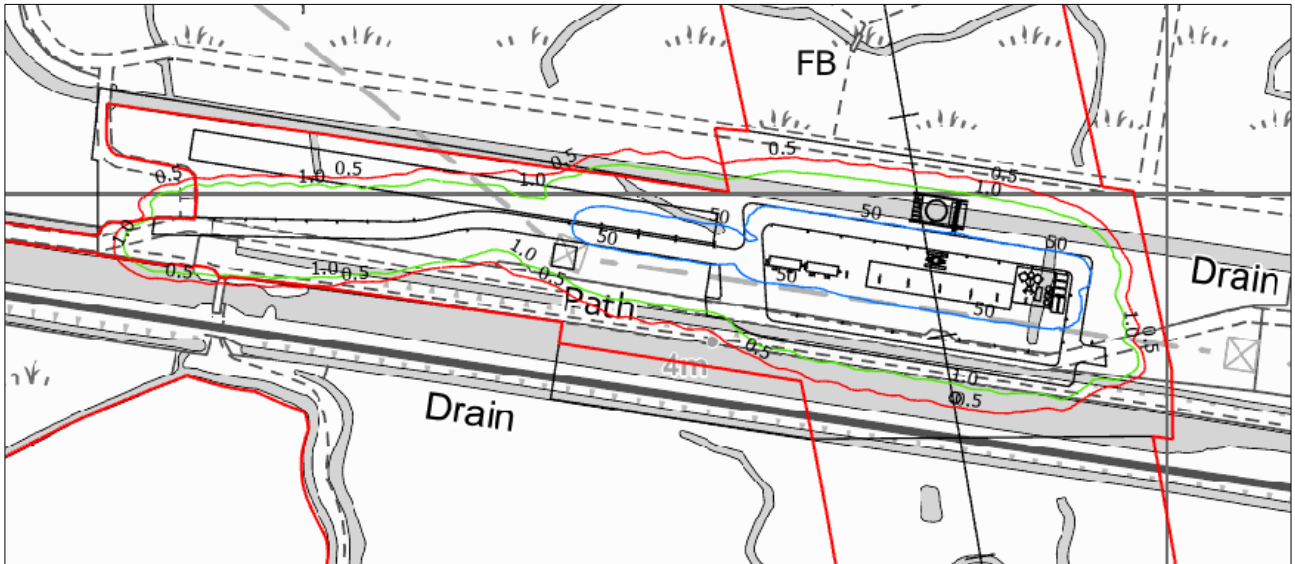
### A226 Gravesend Road compound

**Plate 3.6: A226 Gravesend Road compound – predicted light spill on adjacent Thames Estuary and Marshes SPA/Ramsar functionally linked land**



### Milton compound

**Plate 3.7: Milton compound - predicted light spill on adjacent Thames Estuary and Marshes Ramsar site and Thames Estuary and Marshes SPA/Ramsar functionally linked land**



## 4 Operation High Level Assessment

### 4.1 Supporting Documents

- 4.1.1 The following documents provide further details on the indicative Operational lighting appraisal, strategy, and design.
- a. HE540039-CJV-GEN-GEN-REP-HWY-00118 - Highways Lighting Strategy
  - b. HE540039-CJV-GEN-GEN-REP-HWY-00122 – Highways Lighting Appraisal
  - c. HE540039-CJV-GEN-GEN-REP-HWY-00144 – Highways Lighting Design Report North of River
  - d. HE540039-CJV-GEN-GEN-REP-HWY-00144 – Highways Lighting Design Report South of River
  - e. HE540039-CJV-GEN-GEN-REP-HWY-00153 – Design Basis – Highways
- 4.1.2 The supporting documents include details of the environmental constraints considered and mitigations used in the indicative road lighting design.
- 4.1.3 The Highways Lighting Appraisal document gives details of the economic justifications behind the decisions whether or not to provide lighting in each area. In brief the result of this appraisal is that the full area to the south of the river should be lit, plus the area directly outside of the north tunnel portal, the areas adjacent to the A13/A1089 junction, and the M25 junction should be lit (also any local road where lighting is already provided should remain lit). The full details behind these recommendations can be seen in the appraisal document.
- 4.1.4 The Highways Lighting Strategy gives a high level review of the lighting standards and guidance documents applicable to the indicative design, and recommendations on the type of lighting equipment to be proposed, its control, positioning etc. The document also makes recommendation on the highways lighting classes to be used for each area and road type based on the recommendations in BS5489 and National Highways standards.
- 4.1.5 The Highways Lighting Design reports give details of the indicative lighting extents, equipment proposed, environmental mitigations, and links to the lighting layout drawings showing column locations, heights, luminaire types etc.

### 4.2 Environmental Zones

- 4.2.1 The project environmental report assessed the areas surrounding the proposed highway route and classified each area in ambient lighting terms, in accordance with the ILP GN01 document as set out in Table 4.1.

**Table 4.1 Environmental zones applicable to each part of the Project**

Area	Environmental Zone	Notes
A2/ M2 and A2 junction	E1/E2	Combination of ANOB, ancient woodland, community woodland, but close to Gravesend and existing A2/ M2 which is lit
Gravesend link, south portal approach and south portal	E1/E2	Farmland, but close to Gravesend which has street lighting, retail/commercial lighting etc.
North portal, north portal approach and Tilbury junction	E1/E2	Farmland, but close to the unlit river and Tilbury which has street lighting, retail/commercial/industrial lighting etc.
Chadwell St Mary link	E2/E3	Farmland but close to Tilbury which has street lighting, retail/commercial/industrial lighting and existing A13 which is lit
A13 junction and Ockendon link	E1	Mardyke river & farmland, close to existing A13 which is lit
LTC M25 junction and M25 junction 29	E1/E2	Rural dwellings, farmland, and close to existing M25 which is lit

4.2.2 The proposed extents of the highways lighting mean that significant areas to the north of the rivers are not proposed to be lit e.g. Mardyke river crossing, which reduces the potential impact of the scheme on the wider environment in both energy consumption and light spill/sky glow.

### 4.3 Operational Lighting and Key Lighting Receptors

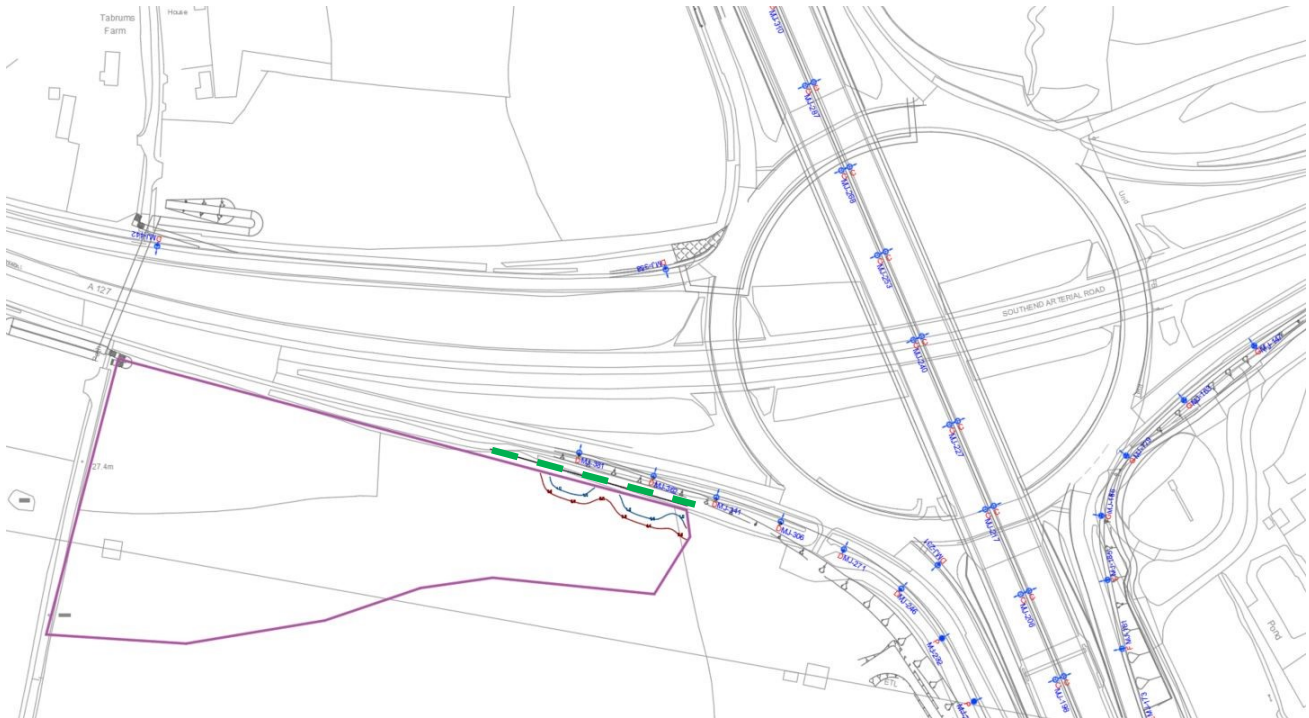
4.3.1 Key lighting receptors have been identified as part of the ecological assessment of the proposed route and the light spill from the indicative lighting design into these areas has been calculated. The results include vertical calculation surfaces placed at the highway boundary to assist with specifying vertical mitigations such as planting, or fences to reduce any potential light spill beyond the boundaries.

4.3.2 In locations where bat roosts have been identified in buildings, addition vertical calculations surfaces were placed on the building faces, to quantify any spill light from the highway operation lighting potentially reaching the roost entrances. Any of these surfaces which returned any light spill values (i.e. any results above zero) are included in the results shown below. The 0.5 lux contour is the red line in all of the plates below.

## North of the River

### M25 Junction 29

**Plate 4.1: Overview of lighting ley receptor area (invertebrates) identified**



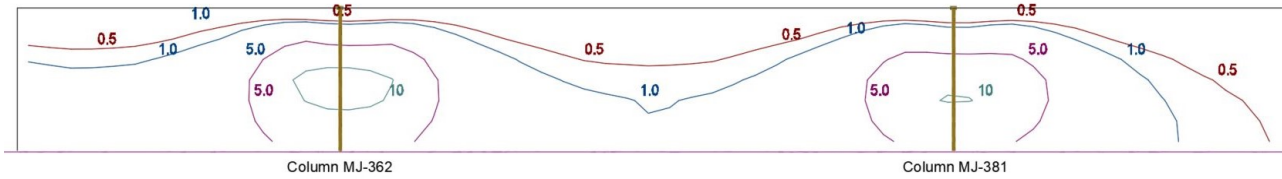
4.3.3 The location of the vertical calculation surface (as shown in Plate 4.1 ) is indicated with a dotted green line above

**Plate 4.2: Close up view of light spill contours in key receptor area**



**Plate 4.3: Vertical view of light spill at field boundary**

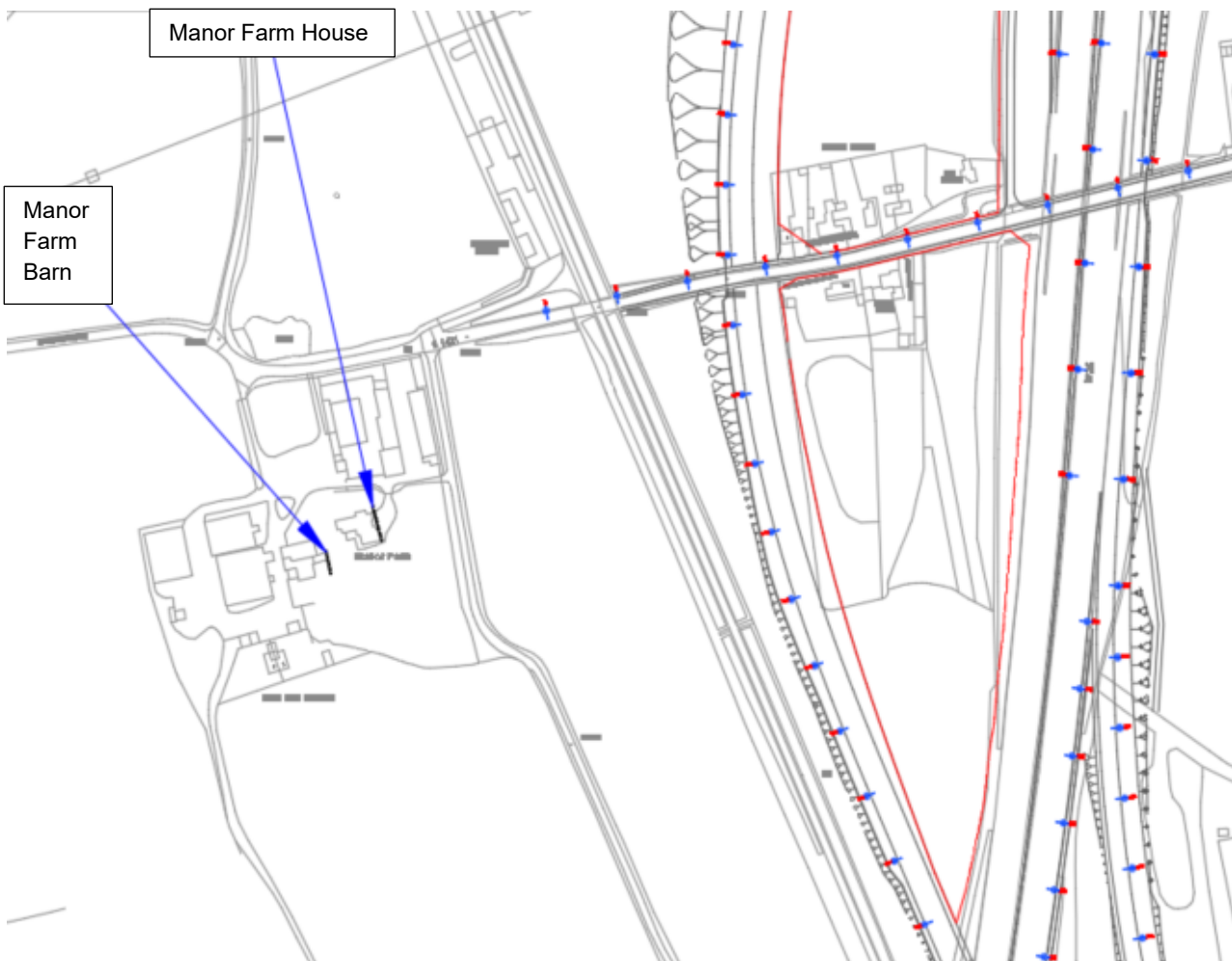
Maximum Calculated value = 12.3 Lux



4.3.4 These results can be seen on Figure 1 (drawing number HE540039-CJV-HLG-S14\_RL000000\_Z-DE-EO-00001) in Annex A.

**LTC northbound to M25 northbound Link**

**Plate 4.4: Overview of Lighting Key Receptor (bat roosts) areas identified**



4.3.5 The identified bat roosts in buildings are indicated above by the blue arrows

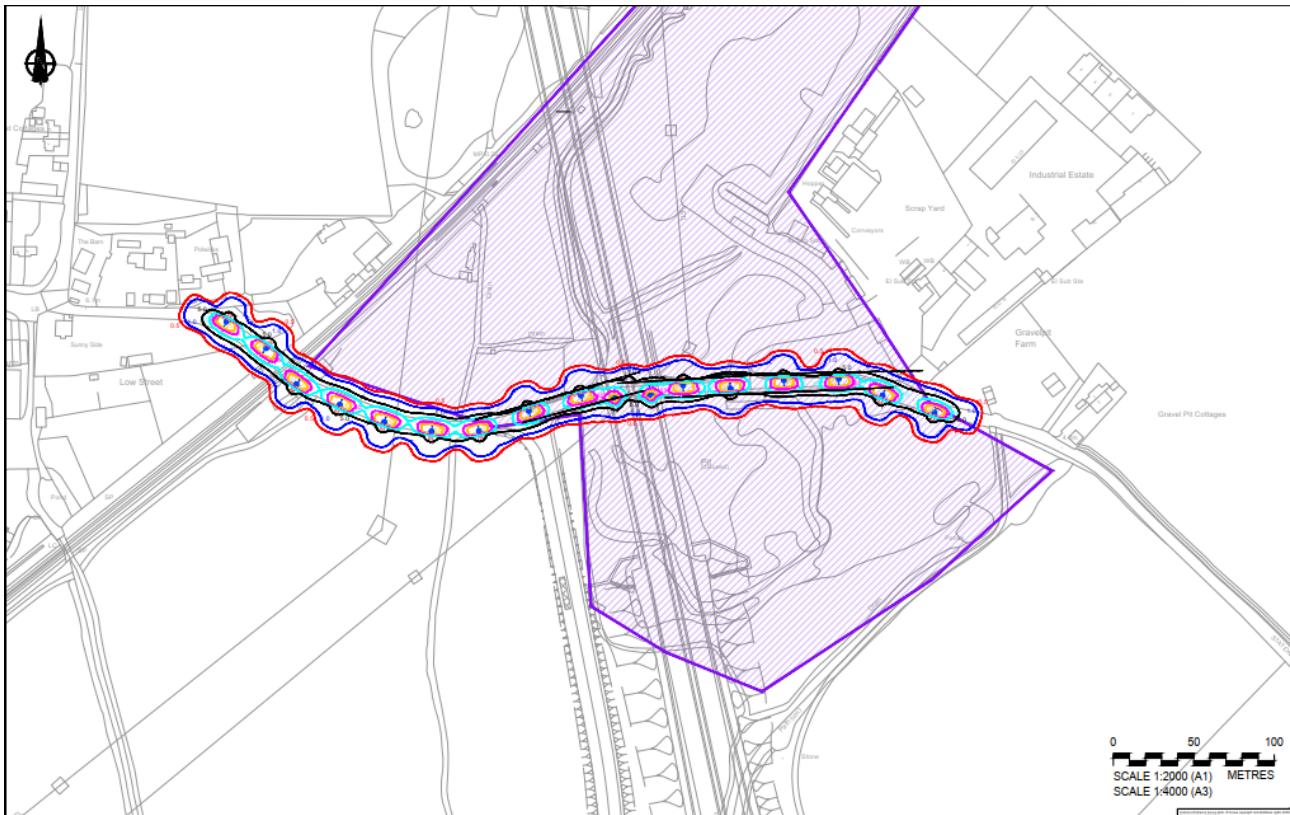
4.3.6 The two vertical calculation surfaces at Manor Farm (for the house and barns) showed zero light spill due to the proposed lighting in both cases. A horizontal calculation surface covering the farm and house grounds also showed zero light spill.

4.3.7 These results can be seen on Figure 2 (drawing number HE540039-CJV-HLG-S13\_RL000000\_Z-DE-EO-00001) in Annex A.

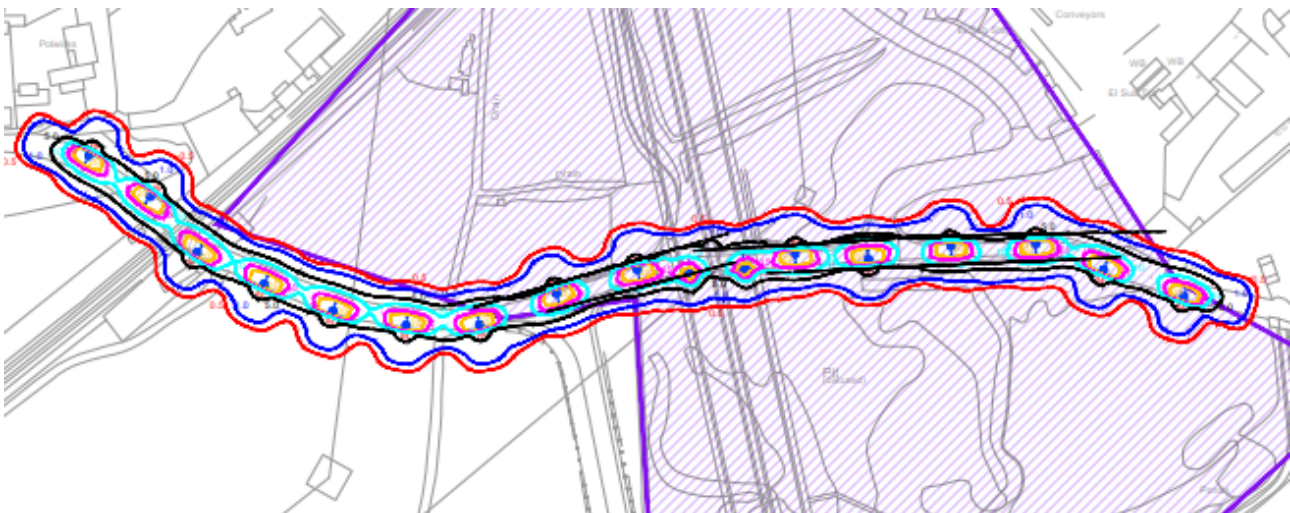


### LTC Tunnel - North Portal, Station Road

**Plate 4.5: Overview of Lighting Key Receptor (Thames Estuary and Marshes SP/Ramsar functionally linked land and invertebrate habitat) areas identified**



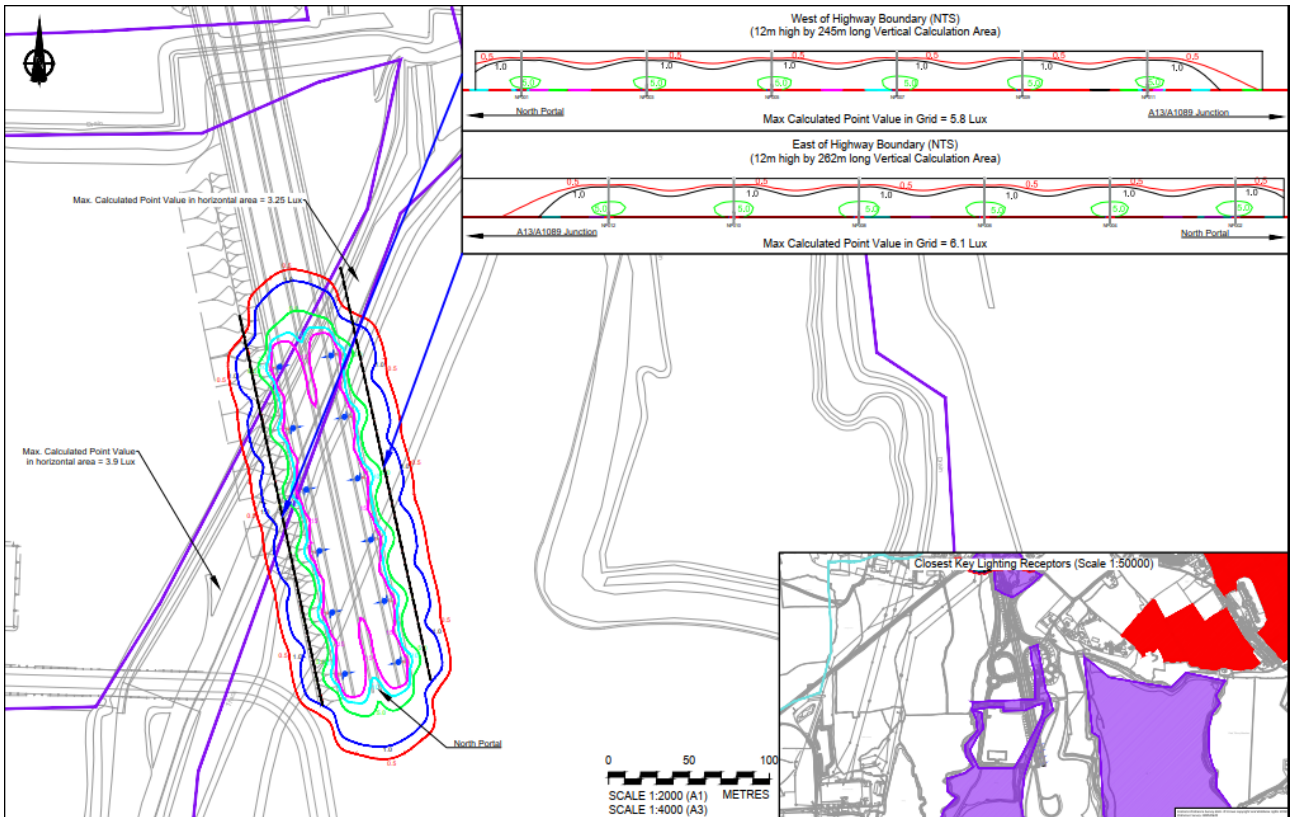
**Plate 4.6: Close up view of light spill contours in key receptor area**



4.3.8 These results can be seen on Figure 3 (drawing number HE540039-CJV-HLG-S07\_RL000000\_Z-DE-EO-00002) in Annex A.

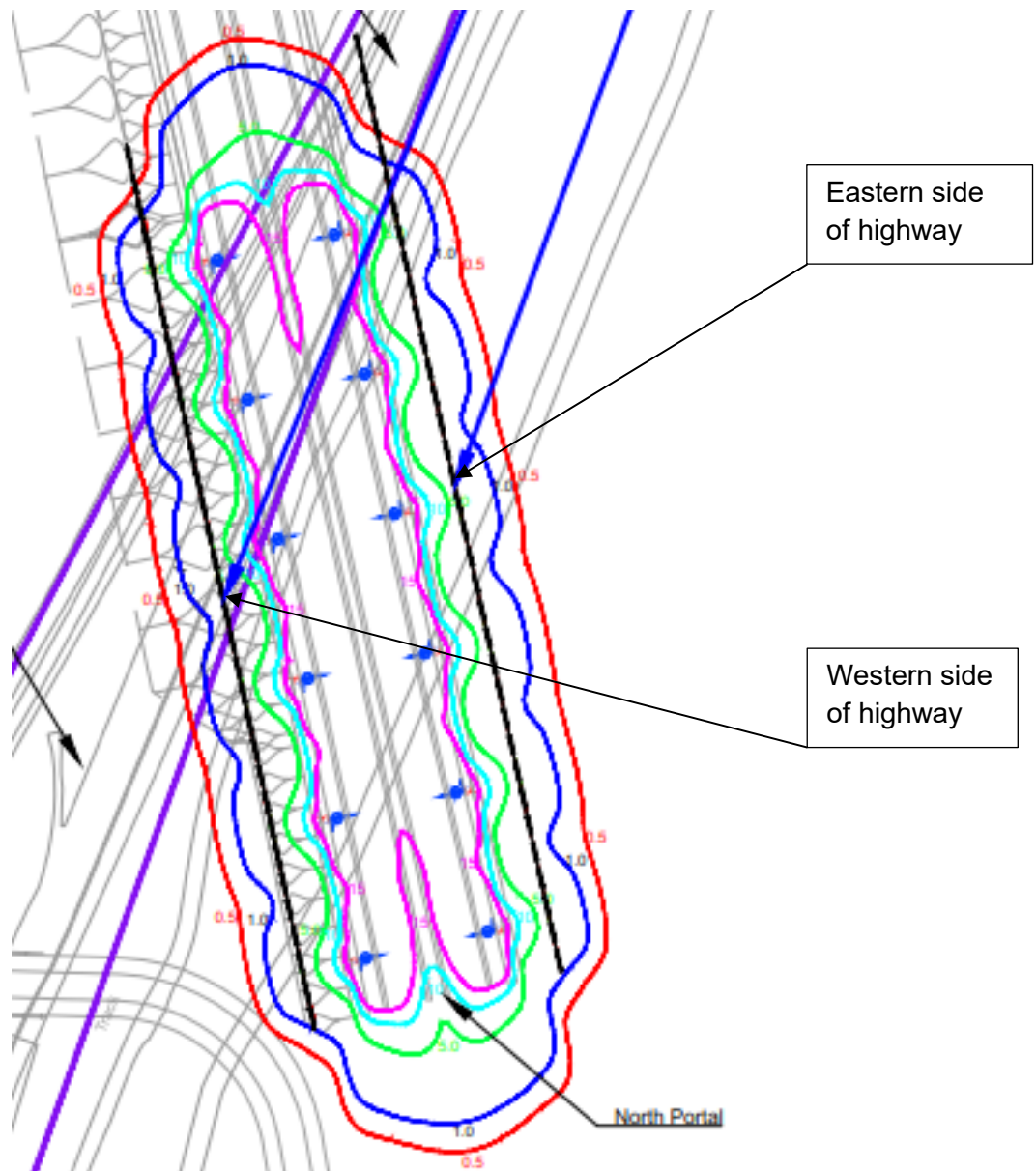
### LTC Tunnel - North Portal

**Plate 4.7: Overview of Lighting Key Receptor (Thames Estuary and Marshes SP/Ramsar functionally linked land and invertebrate habitat) areas identified**



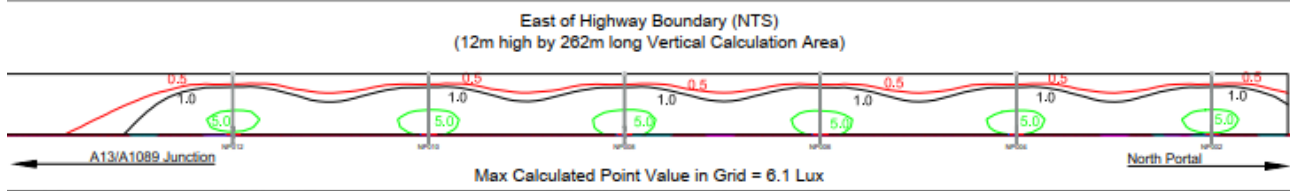


**Plate 4.8: Close up view of light spill contours in key receptor area**



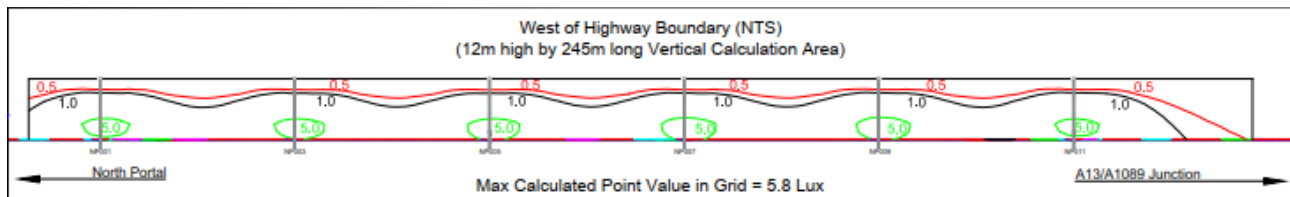
**Plate 4.9: Vertical calculation – Eastern side of highway (12m tall)**

Maximum Calculated value in horizontal area = 3.25 Lux



**Plate 4.10: Vertical calculation – Western side of highway (12m tall)**

Maximum Calculated value in horizontal area = 3.9 Lux



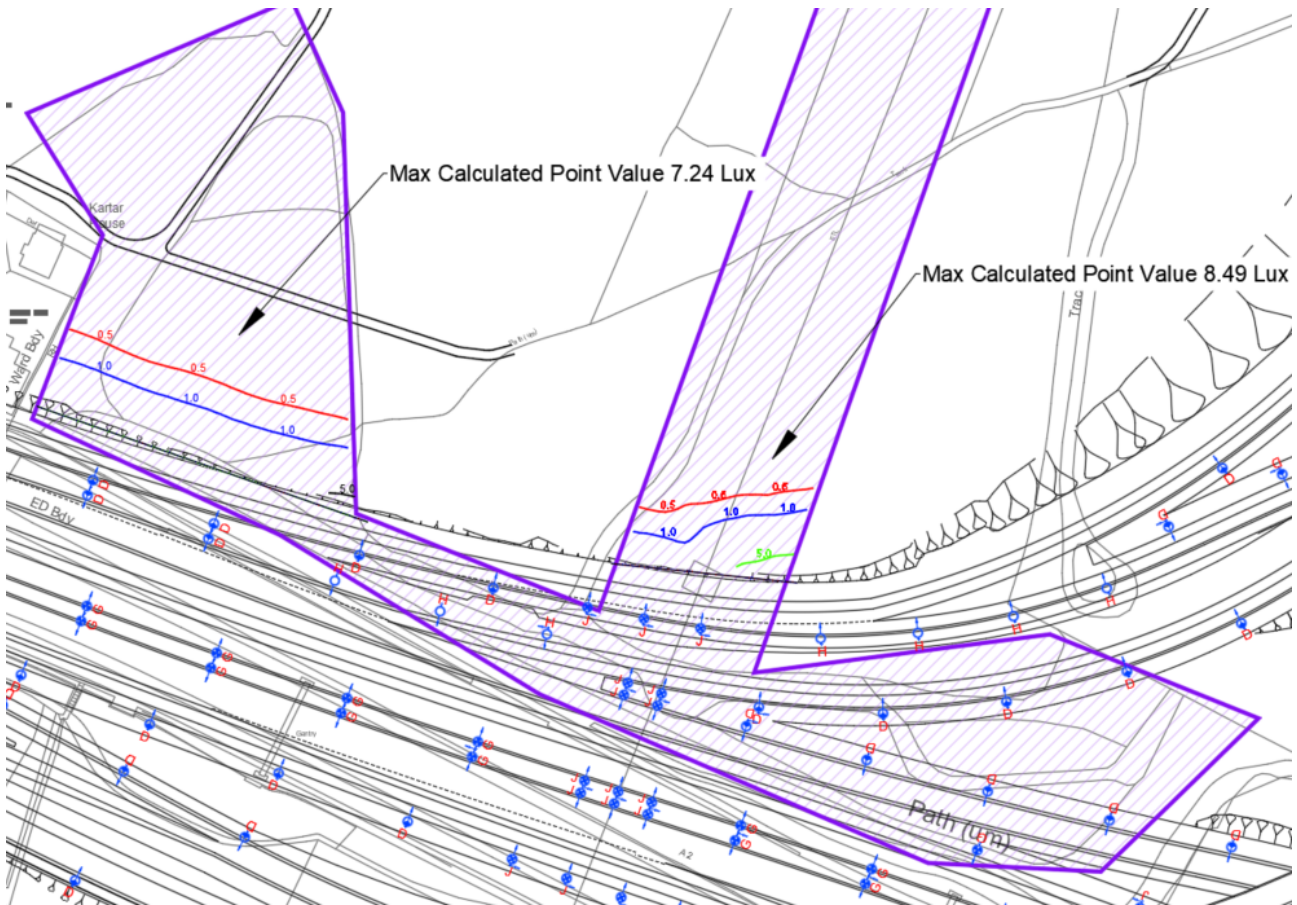
4.3.9 The above calculations for the north tunnel entrance spill lighting assumed that the 12m columns are mounted at the same level as the receptor calculation surface, however they will actually be in a cutting and this will effectively reduce the height of the columns relative to the receptors, and reduce the light spill significantly. The combined height of the cutting embankments and bund relative to the road surface/column base level is are being developed. The calculation therefore shows the ‘worst case scenario’ from a light spill perspective.

4.3.10 These results can be seen on Figure 4 (drawing number HE540039-CJV-HLG-S07\_RL000000\_Z-DE-EO-00001) in Annex A.

## South of the River

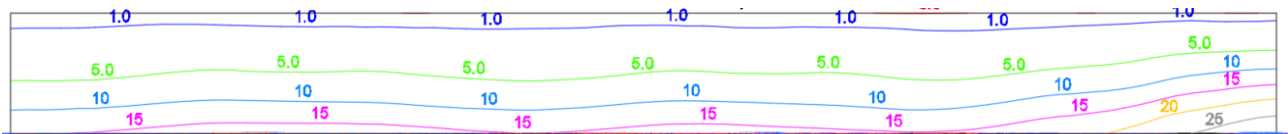
### South of the River M2/LTC West Side

**Plate 4.11: Close up view of light spill contours in key receptor area (invertebrates)**



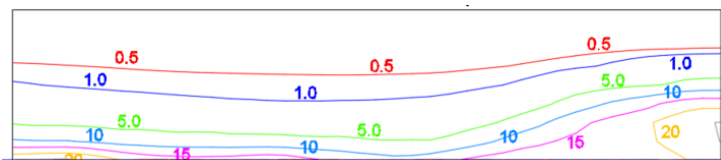
**Plate 4.12: Vertical calculation – Western Boundary with highway (10m tall)**

Maximum Calculated value = 28.9 Lux

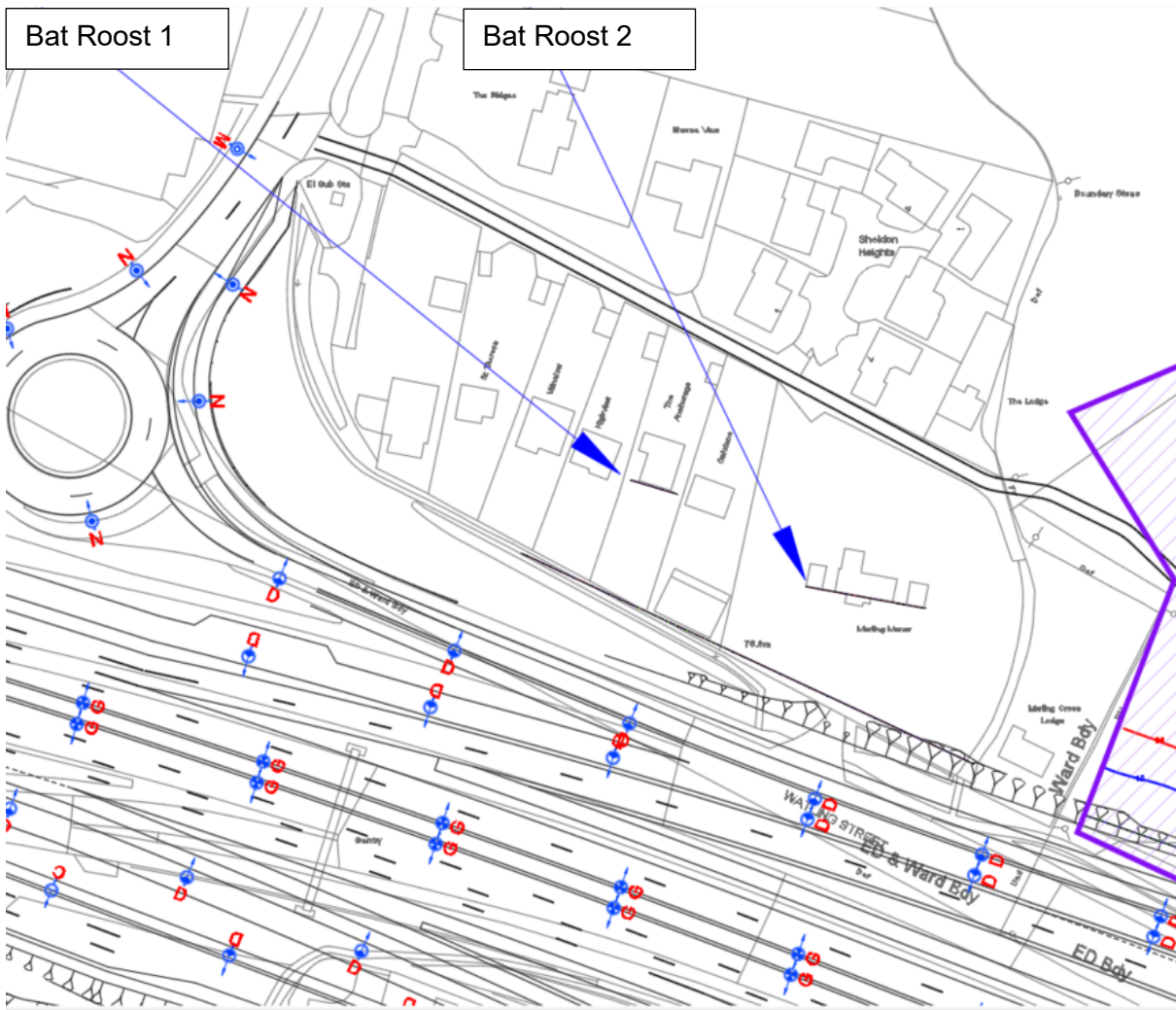


**Plate 4.13: Vertical calculation – Eastern Boundary with highway (10m tall)**

Maximum Calculated value = 25.8 Lux

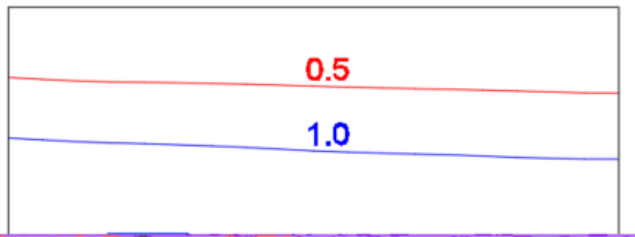


**Plate 4.14: Close up view of light spill contours in key receptor area (bat roosts)**



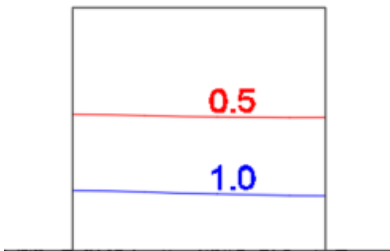
**Plate 4.15: Vertical calculation – Bat Roost 1 Building Facade (10m tall)**

Maximum Calculated value = 2.4 Lux



**Plate 4.16: Vertical calculation – Bat Roost 2 Building Facade (10m tall)**

Maximum Calculated value = 1.6 Lux



4.3.11 These results can be seen on Figure 5 (drawing number HE540039-CJV-HLG-SSZ\_RL000000\_Z-DE-EO-00001) in Annex A.



South of River M2/LTC East Side

Plate 4.17: Overview – Shorne Woods Ancient Woodland Areas

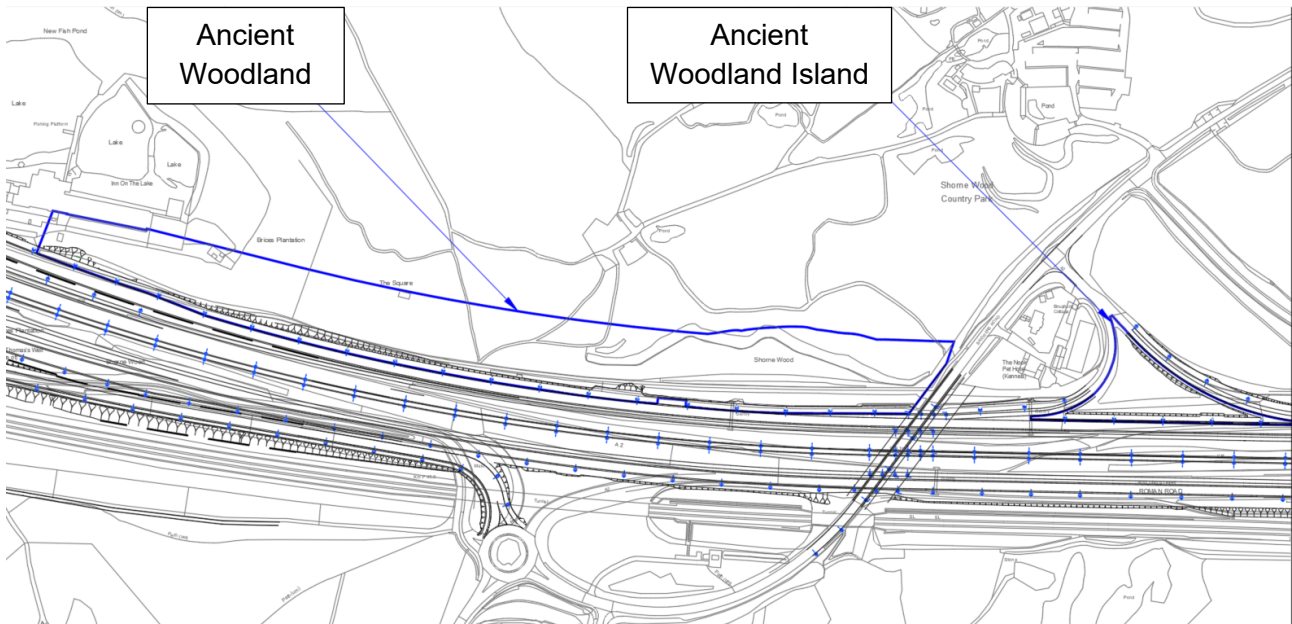


Plate 4.18: Close up view of light spill contours in key receptor area

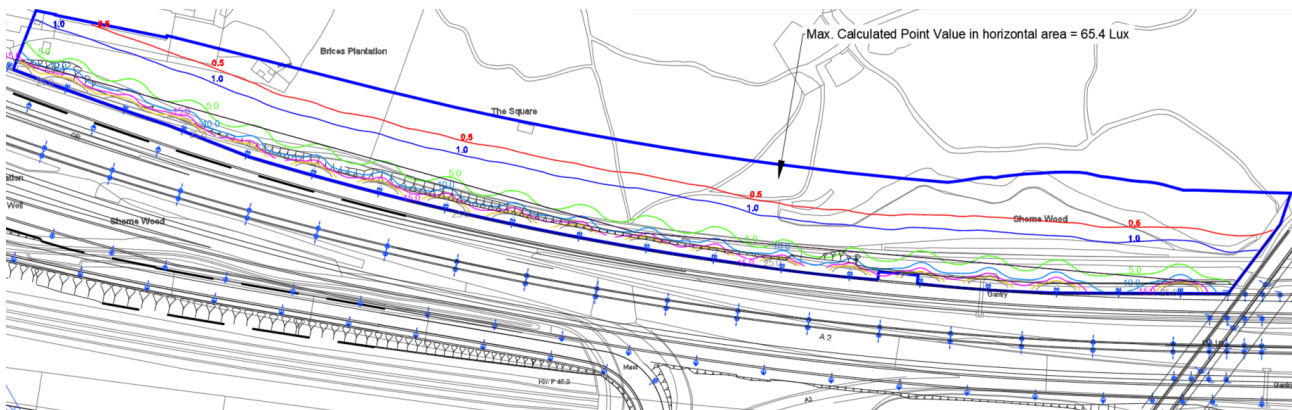
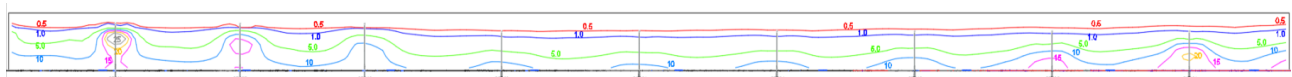


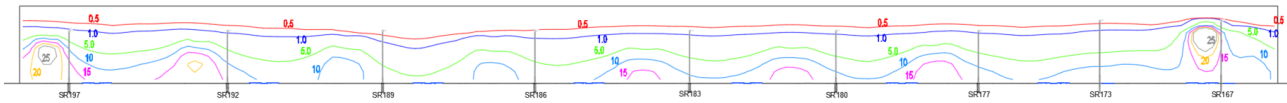
Plate 4.19: Vertical calculation – Ancient Woodland West (15m tall)

Maximum Calculated value = 35.9 Lux



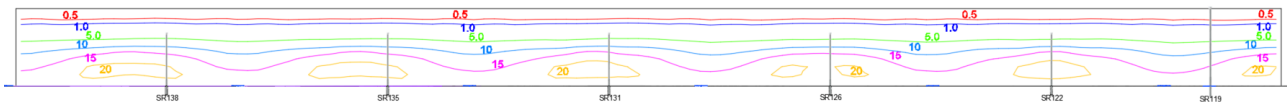
**Plate 4.20: Vertical calculation – Ancient Woodland East (15m tall)**

Maximum Calculated value = 59.2 Lux



**Plate 4.21: Vertical calculation – Ancient Woodland Island (15m tall)**

Maximum Calculated value = 21.4 Lux



4.3.12 The above calculations for the Ancient Woodland area spill lighting assumes that the 12m verge and 15m central reserve columns are all mounted at the same level as the receptor calculation surface, however the columns will actually be in a cutting with embankments, this will effectively reduce the height of the columns relative to the receptors, and therefore reduce the extent of any light spill. The calculation also excludes the blocking effect of any trees, shrubs etc which would significantly reduce the extents of any potential light spill. The height of the cutting embankments relative to the road surface/column base level are being developed. The calculation therefore shows the ‘worst case scenario’ from a light spill perspective.

4.3.13 These results can be seen on Figure 6 (drawing number HE540039-CJV-HLG-SSZ\_RL000000\_Z-DE-EO-00002) in Annex A.

## Glossary

Term	Explanation
Curfew	Time during which stricter requirements (for the control of obtrusive light) would apply; often a condition of use of lighting applied by a government controlling authority, usually the local government
Colour Rendering	Colour rendering (as per BS EN 12665:2018) Effect of an illuminant on the colour appearance of objects by conscious or subconscious comparison with their colour appearance under a reference illuminant. E.g. how closely a colour matches when viewed under artificial light compared to the same sample viewed under daylight
Diversity	Ratio of minimum illuminance (luminance) to maximum illuminance (luminance) on (of) a surface
Glare	Glare is a visual sensation caused by excessive and uncontrolled brightness. It can be disabling or simply uncomfortable.
Glare Rating Limit	Upper limit of glare by the CIE Glare Rating system
Illuminance	Quotient of the luminous flux ( $d\phi$ ) incident on an element of the surface containing the point, by the area ( $dA$ ) of that element. Equivalent definition: Integral, taken over the hemisphere visible from the given point, of the expression Unit: $L \times \cos \theta \times d\Omega$ . Where $L$ is the luminance at the given point in the various directions of the incident elementary beams of solid angle $d\Omega$ ; and $\theta$ is the angle between any of these beams and the normal to the surface at the given point. Unit $Lx$ (lux) or lumens per metre <sup>2</sup> ( $lm/m^2$ ).
Illuminance Uniformity	Ratio of minimum illuminance to average illuminance on a surface. Note: Use is also made of the ratio of minimum illuminance to maximum illuminance, in which case, this should be specified explicitly.
Lamp	Light source made in order to produce optical radiation, usually visible. Note: This term is also sometimes incorrectly used for certain types of luminaires.
LED	A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it.
Light Pollution	The spillage of light into areas where it is not desired.
Lighting Class	A series of lighting targets for roadways/cycle lanes/pedestrian areas dependent upon criteria such as the road type, traffic volume, speed limit, environment, and a risk assessment to take other factors into consideration such as the presence of schools, or sports grounds.
Luminaire	Apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply. Note: The term 'light fitting' is deprecated.



<b>Term</b>	<b>Explanation</b>
Maintained Illuminance	Value below which the average illuminance on the specified surface is not allowed to fall. It is the average illuminance at the time during which maintenance should be carried out. Unit: Lx (Lux) or lm/m2.
Minimum Illuminance	Lowest illuminance at any relevant point on the specified surface. Unit: Lx or lm/m2 Note: The relevant points at which the illuminances are determined shall be specified in the appropriate application standard.
Obtrusive/Nuisance Light	Which because of quantitative, directional or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction or a reduction in the ability to see essential information
Spill Light	Light emitted by a lighting installation which falls outside the boundaries of the property for which the lighting installation is designed
Task Area	partial area in the workplace in which the visual task is carried out. For places where the size and/or location of the task area are unknown, the area where the task may occur is the task area
Upward Light Ratio	Proportion of the flux of the luminaire(s) that is emitted above the horizontal, when the luminaire(s) is (are) mounted in its (their) installed position and attitude

### Abbreviation Table

<b>Abbreviation</b>	<b>Term</b>
CRI	Colour Rendering Index
IDA	International Dark-Sky Association
ILP	Institution of Lighting Professionals
GN	Guidance Note
LED	Light Emitting Diode
LMP	Lighting Management Plan
SLL	Society of Light and Lighting
SSSI	Site of Special Scientific Interest
ULR	Upward Light Ratio of the Installation

## Annex A Figures

Figure 1 M25 Junction 29 Light Spill Calculation Results

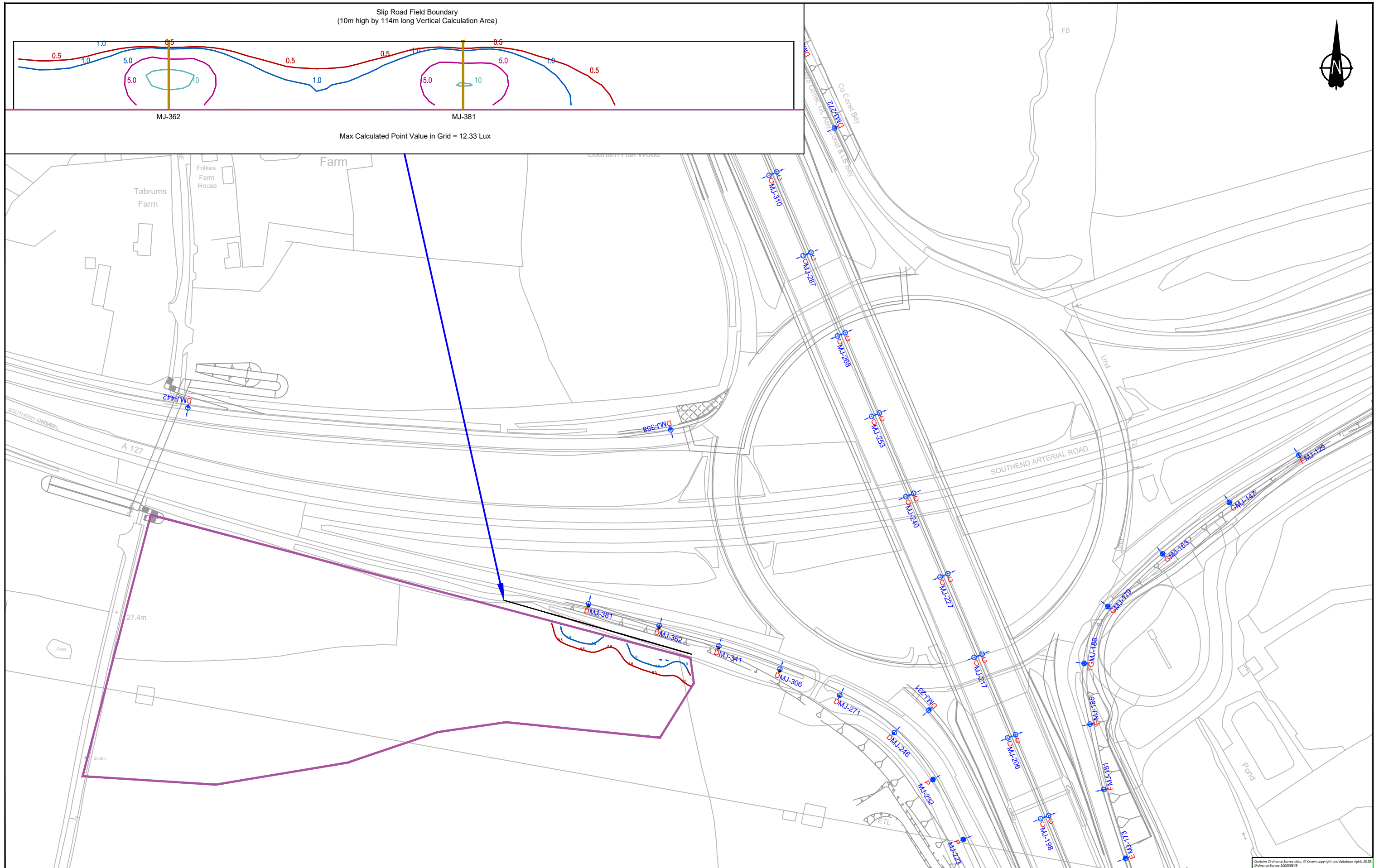
Figure 2 M25 Light Spill Calculation Results

Figure 3 North Portal (Station Road) Light Spill Calculation Results

Figure 4 North Portal Light Spill Calculation Results

Figure 5 South of River (West Side) Light Spill Calculation Results

Figure 6 South of River (East Side) Light Spill Calculation Results



Rev	Status	Rev. Date	Purpose of revision	Drawn	Check'd	Appr'd
P01	S3	26/03/2020	Design Release 3 and for DCO	AW	NH	PP
P02	S3	10/11/2021	Design Release 3 and for DCO	AW		
P03	S2	05/07/2022	Design Release 3 and for DCO	LM	NH	PP

**Notes:**

1. For lighting symbol key refer to drawing HLG-SZP\_RL000000\_Z-DR-EO-00001
2. Illuminance contours shown are in Lux
3. Results shown are worst case based on no obstructions to the light, e.g. hedges, trees etc. and that lighting columns and calculations are all at the same base height.

0 10 20 30 40 50 100  
 SCALE 1:2500 (A3) METRES  
 SCALE 1:1250 (A1)

Client

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 15 St Botolph Street  
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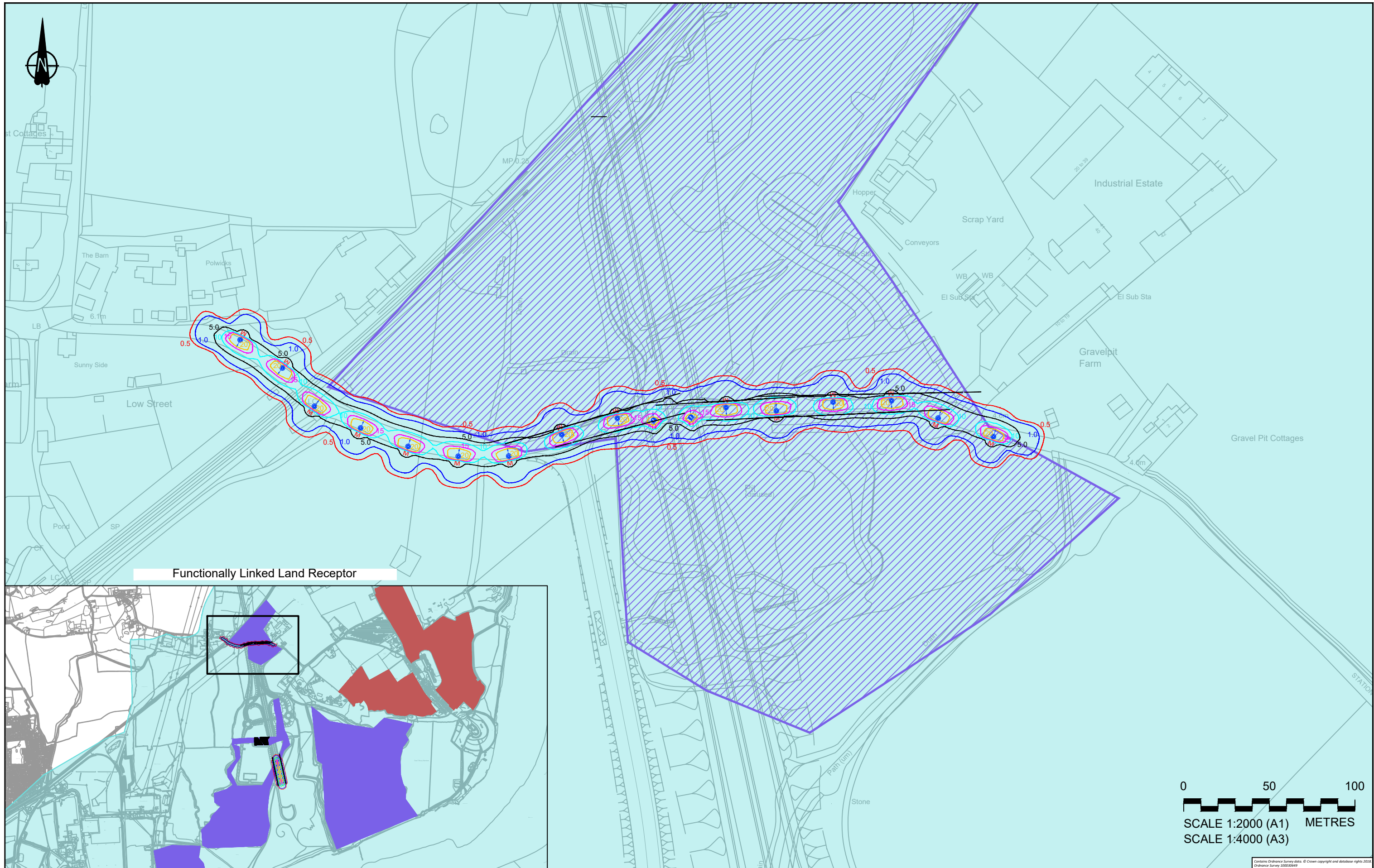
Project **LOWER THAMES CROSSING**

Drawing title  
**Figure 1  
 M25 Junction 29  
 Light Spill Calculation Results**

Status	S2	Fit for Information	Original Size	A3	Revision	P03
Scale			Date	05/07/2022		
Drawn	LM		Date	05/07/2022		
Checked	NH		Date	05/07/2022		
Approved	PP		Date	05/07/2022		
Drawing number	HE540039-CJV-HLG-S14_RL000000_Z-DE-EO-00001					







Functionally Linked Land Receptor



- Notes:
1. For lighting symbol key refer to drawing HLG-SZP\_RL000000\_Z-DR-EO-00001
  2. Illuminance contours shown are in Lux
  3. Results shown are worst case based on no obstructions to the light, e.g. hedges, trees etc. and that lighting columns and calculations are all at the same base height (i.e. no allowance for embankments, changes in height etc).

P01	S3	26/03/2020	Design Release 3.0 and for DCO	AW	NH	PP
P02	S3	10/11/2021	Design Release 3.0 and for DCO	AW		
P03	S2	05/07/2022	Design Release 3.0 and for DCO	LM	NH	PP
P04.1	S0	25/07/2022	Design Release 3.0 and for DCO	LM	NH	PP
Rev	Status	Rev. Date	Purpose of revision	Drawn	Check'd	Approved

Client

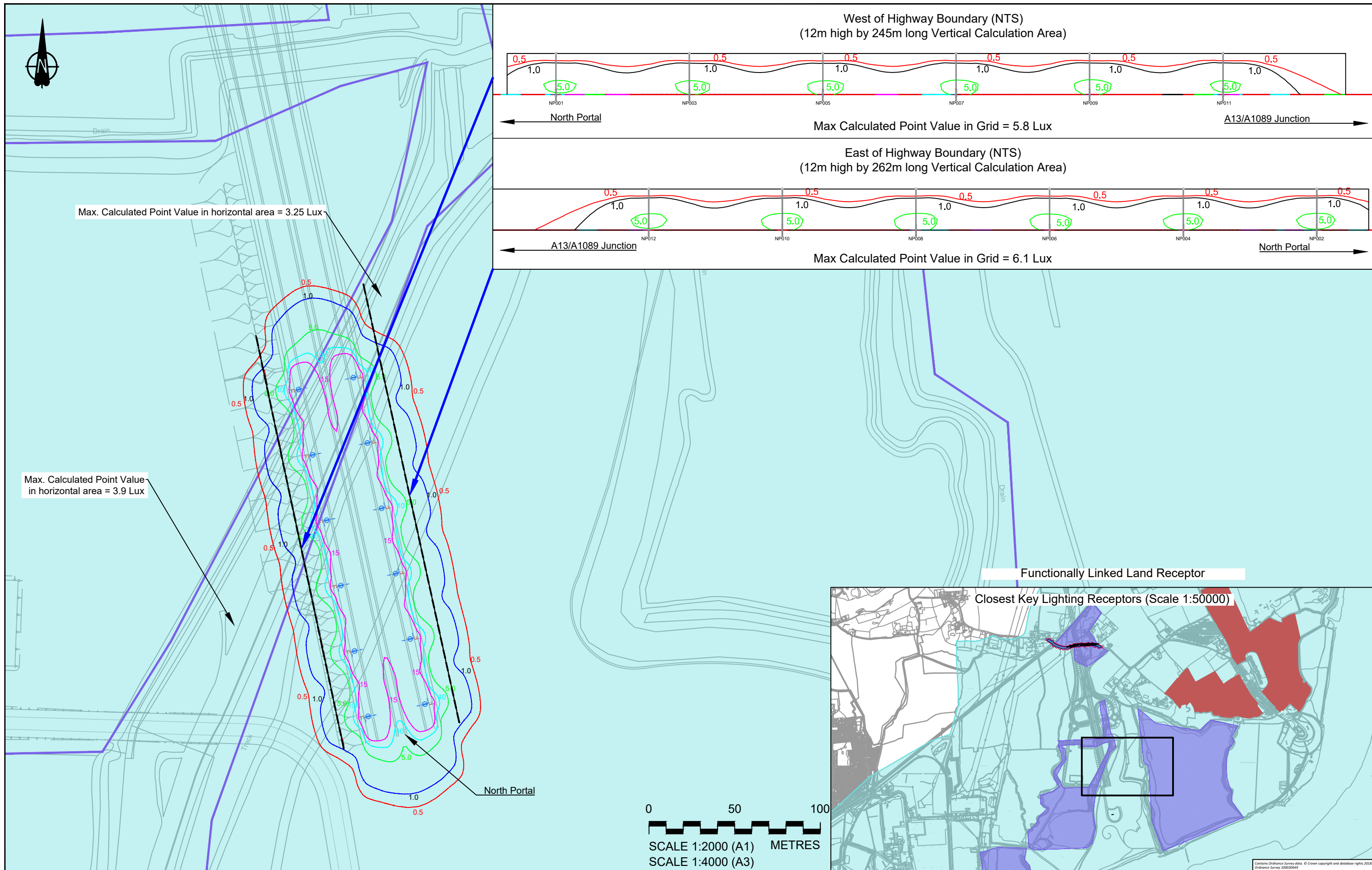
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Project **LOWER THAMES CROSSING**

Drawing title **Figure 3  
North Portal (Station Road)  
Light Spill Calculation Results**

Status	S0	Initial Status or WIP	Original Size	A3	Revision	P04.1
Scale	1:2000		Date	25/07/2022		
Drawn	LM	Date	25/07/2022			
Checked	NH	Date	25/07/2022			
Approved	PP	Date	25/07/2022			
Drawing number	HE540039-CJV-HLG-S07_RL000000_Z-DE-EO-00002					



Rev	Status	Rev. Date	Purpose of revision	Drawn	Check'd	Approved
P01	S3	26/03/2020	Design Release 3 and for DCO	AW	NH	PP
P02	S3	10/11/2021	Design Release 3 and for DCO	AW		
P03	S2	05/07/2022	Design Release 3 and for DCO	LM	NH	PP
P04.1	S0	25/07/2022	Design Release 3 and for DCO	LM	NH	PP

Notes:

- For lighting symbol key refer to drawing HLG-SZP\_RL000000\_Z-DR-EO-00001
- Illuminance contours shown are in Lux
- Results shown are worst case based on no obstructions to the light, e.g. hedges, trees etc. and that lighting columns and calculations are all at the same base height (i.e. no allowance for embankments, changes in height etc).

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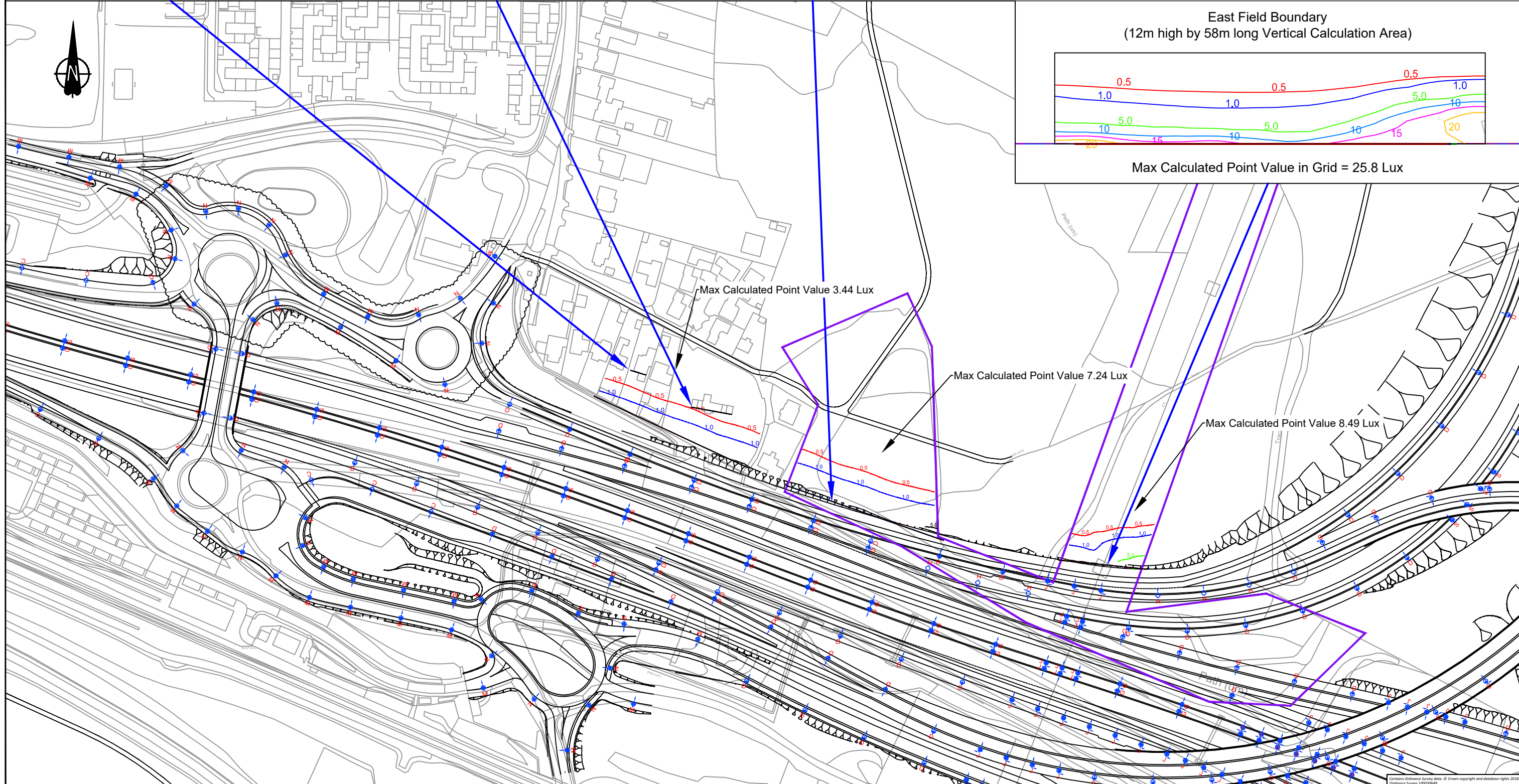
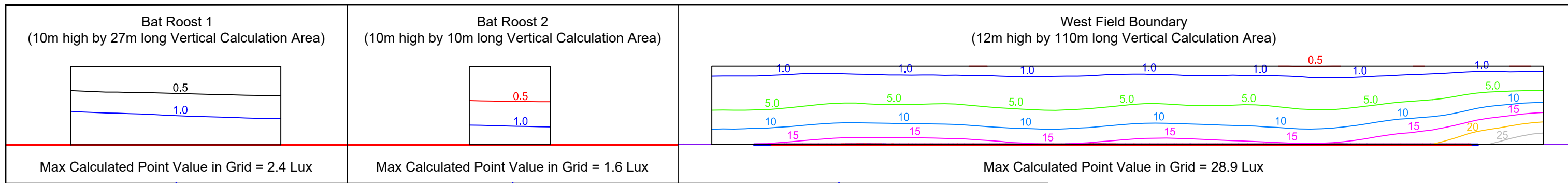
Project LOWER THAMES CROSSING

Drawing title

**Figure 4**  
**North Portal**  
**Light Spill Calculation Results**

Status	Initial Status or WIP	Original Size	Revision
S0		A3	P04.1
Drawn	LM	Scale	1:2500
Checked	NH	Date	25/07/2022
Approved	PP	Date	25/07/2022
Drawing number HE540039-CJV-HLG-S07_RL000000_Z-DE-EO-00001			





Rev	Status	Rev. Date	Purpose of revision	Drawn	Check'd	Appr'd
P01	S3	11/03/2020	Design Release 3 and for DCO	AW	NH	PP
P02	S3	10/11/2021	Design Release 3 and for DCO	AW	NH	PP
P03	S2	05/07/2022	Design Release 3 and for DCO	LM	NH	PP

**Notes:**

1. For lighting symbol key refer to drawing HLG-SZP\_RL000000\_Z-DR-EO-00001
2. Illuminance contours shown are in Lux
3. Results shown are worst case based on no obstructions to the light, e.g. hedges, trees etc. and that lighting columns and calculations are all at the same base height.

0 10 20 30 40 50 100  
SCALE 1:2500 (A3) METRES  
SCALE 1:1250 (A1)

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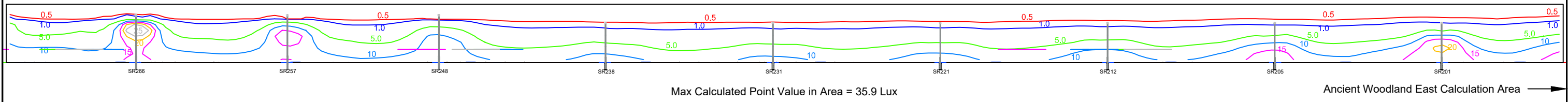
Project **LOWER THAMES CROSSING**

Drawing title **Figure 5  
South of River (West Side)  
Light Spill Calculation Results**

Status	S2	Fit for Information	Original Size	A3	Revision	P03
Scale	1:5000		Date	05/07/2022		
Drawn	LM	Checked	NH	Date	05/07/2022	
Approved	PP	Date	05/07/2022			
Drawing number	HE540039-CJV-HLG-SSZ_RL000000_Z-DE-EO-00001					



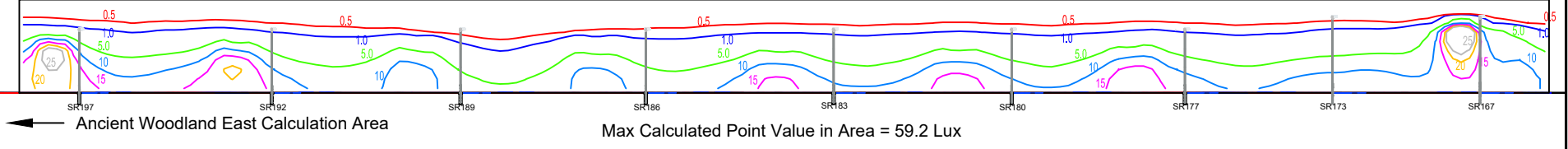
Ancient Woodland Edge (West)  
(15m high by 400m long Vertical Calculation Area)



Max Calculated Point Value in Area = 35.9 Lux

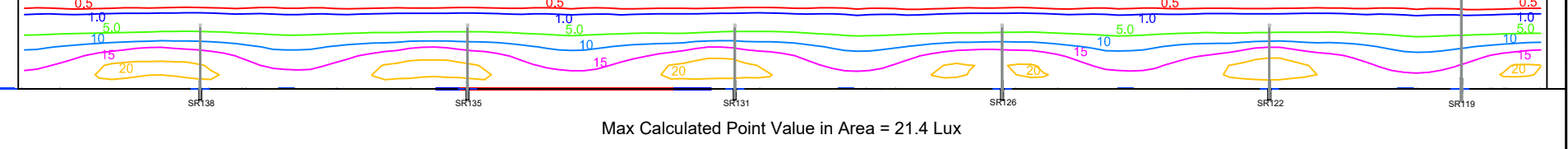
Ancient Woodland East Calculation Area

Ancient Woodland Edge (East)  
(15m high by 366m long Vertical Calculation Area)



Max Calculated Point Value in Area = 59.2 Lux

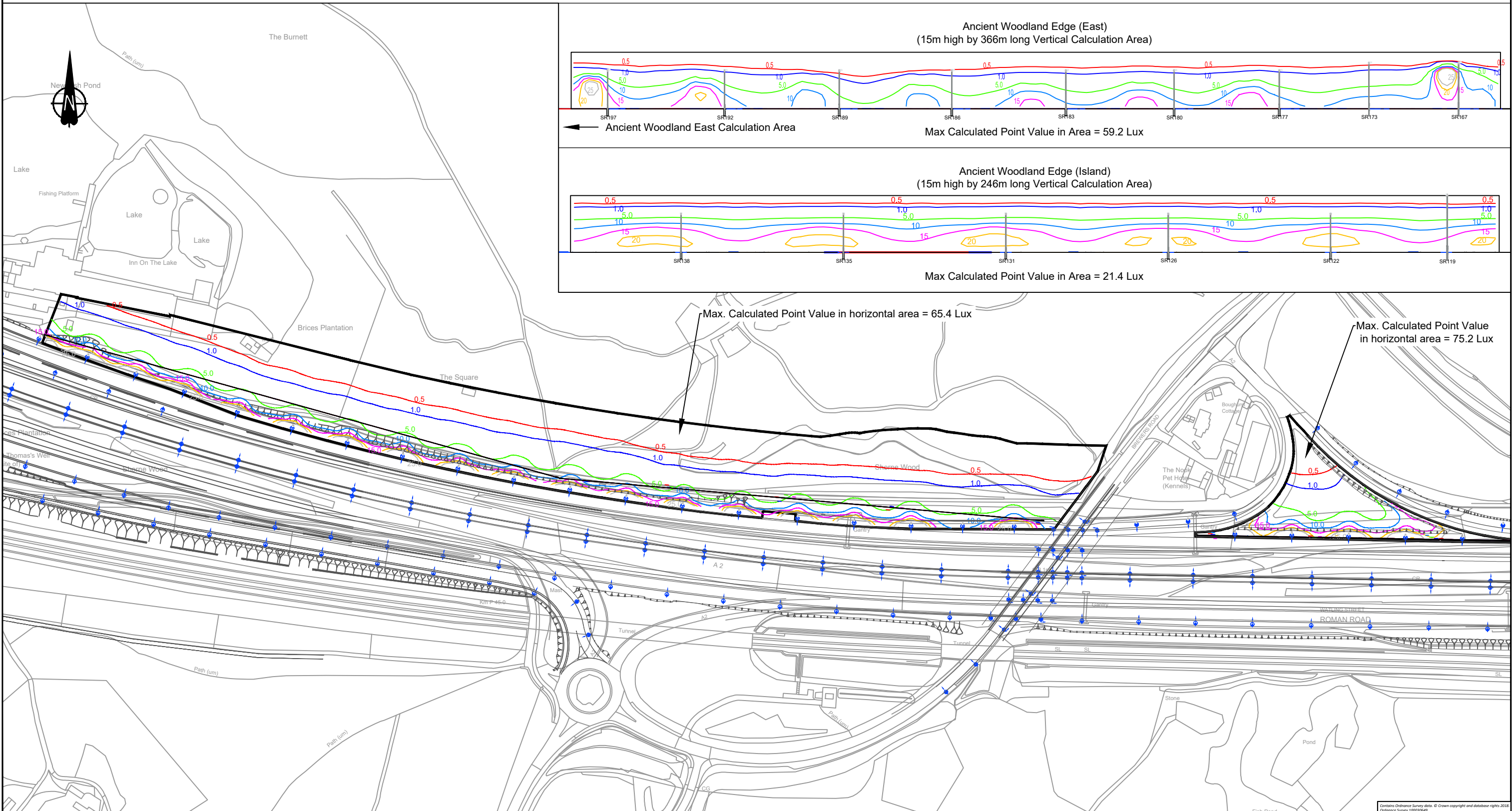
Ancient Woodland Edge (Island)  
(15m high by 246m long Vertical Calculation Area)



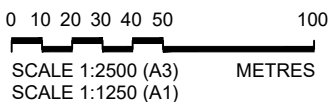
Max Calculated Point Value in Area = 21.4 Lux

Max. Calculated Point Value in horizontal area = 65.4 Lux

Max. Calculated Point Value in horizontal area = 75.2 Lux



- Notes:
1. For lighting symbol key refer to drawing HLG-SZP\_RL000000\_Z-DR-EO-00001
  2. Illuminance contours shown are in Lux
  3. Results shown are worst case based on no obstructions to the light, e.g. hedges, trees etc. and that lighting columns and calculations are all at the same base height (i.e. no allowance for embankments, changes in height etc).



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Project LOWER THAMES CROSSING

Drawing title

**Figure 6**  
South of River (East Side)  
Light Spill Calculation Results

Status	S2	Fit for Information	Original Size	A3	Revision	P01
Scale			Date	05/07/2022		
Drawn	LM		Date	05/07/2022		
Checked	NH		Date	05/07/2022		
Approved	PP		Date	05/07/2022		
Drawing number	HE540039-CJV-HLG-SSZ_RL000000_Z-DE-EO-00002					

Rev	Status	Rev. Date	Purpose of revision	Drawn	Check'd	Approved
P01	S2	05/07/2022	First Release	LM	NH	PP

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